Table 4-24. Projected Flows and Percent Change from 2009 Flows during Average Rainfall Year and 50 Percent Capture at the Peace River at Arcadia Flow Station with the Ona Mine

	Annual Average Flow (cfs)	Annual Average Percent Change from 2009 Flows	Dry Season Average Flow (cfs)	Dry Season Average Percent Change from 2009 Flows	Wet Season Average Flow (cfs)	Wet Season Average Percent Change from 2009 Flows
2009	713	0%	328	0%	1,657	0%
2020	726	2%	332	1%	1,702	3%
2030	738	4%	336	2%	1,742	5%
2040	753	6%	342	4%	1,783	8%
2050	771	8%	350	7%	1,827	10%
2060	783	10%	355	8%	1,858	12%

The same evaluation was performed for a low rainfall year. Tables 4-25 and 4-26 present the annual average flows and seasonal flow rates calculated for a low rainfall year for Peace River at Arcadia with the Ona Mine for the 100 percent and 50 percent stormwater capture scenario, respectively. Changes in flows are indistinguishable from the No Action Alternative.

Table 4-25. Projected Flows and Percent Change from 2009 Flows during Low Rainfall Year and 100 Percent Capture at the Peace River at Arcadia Flow Station with the Ona Mine

	Annual Average Flow (cfs)	Annual Average Percent Change from 2009 Flows	Dry Season Average Flow (cfs)	Dry Season Average Percent Change from 2009 Flows	Wet Season Average Flow (cfs)	Wet Season Average Percent Change from 2009 Flows
2009	330	0%	152	0%	766	0%
2020	336	2%	154	1%	787	3%
2030	341	3%	155	2%	806	5%
2040	348	5%	158	4%	825	8%
2050	357	8%	162	7%	847	11%
2060	363	10%	164	8%	862	13%

Table 4-26. Projected Flows and Percent Change from 2009 Flows during Low Rainfall Year and 50 Percent Capture at the Peace River at Arcadia Flow Station with the Ona Mine

	Annual Average Flow (cfs)	Annual Average Percent Change from 2009 Flows	Dry Season Average Flow (cfs)	Dry Season Average Percent Change from 2009 Flows	Wet Season Average Flow (cfs)	Wet Season Average Percent Change from 2009 Flows
2009	330	0%	152	0%	766	0%
2020	336	2%	154	1%	787	3%
2030	342	4%	156	3%	807	5%
2040	349	6%	159	5%	826	8%
2050	358	9%	163	7%	848	11%
2060	363	10%	165	9%	862	13%

4.2.3.4 Ona Mine: Degree and Significance of Surface Water Resource Effects

While the Horse Creek flow rate from mining is projected to decrease up to 9 percent during a low rainfall year in the dry season with a 100 percent capture area, the decrease in flow rates falls within the error range for this analysis which is based on an extremely variable parameter (rainfall). The reduction in flows within Horse Creek may be indicative of a change at the Horse Creek subwatershed level; therefore, the effect cannot be considered minor. For a major effect, there must be an extended effect on surface water flows at least at the subwatershed level that also leads to a violation of the MFLs for the subwatershed. In addition to the potential reductions being within one order of significant figures, there are no SWFWMD MFLs established for Horse Creek to which the flow reduction can be compared. For this reason (no contribution to a violation of MFLs for Horse Creek and a change in stream flow rates that falls within the expected error range), the effect on surface water flows within Horse Creek cannot be considered to have a major effect. The apparent reduction in flow is indicative of a change beyond the boundaries of the mine within the Horse Creek subwatershed even though the degree may be within the realm of natural variation. Therefore, the effects would be moderate without mitigation and minor with mitigation within the Horse Creek subwatershed. Given the moderate level of an effect for this mine within the watershed, the effect is expected to be significant without mitigation but not significant with mitigation considered.

Possible measures that would reduce the moderate degree of effect, mitigate the intensity factors, and potentially make the effects not significant include recharge ditches and wells to maintain base flow in Horse Creek and its tributaries, or reducing the capture area. There are also monitoring program and other provisions in FDEP mining permits. If it is determined through monitoring that there is an unanticipated impact to the creek, the Applicants would need to address those impacts.

The effects within the Peace River at Arcadia and Upper Myakka River subwatersheds are minor to no effect and are not considered significant.

The individual effect of the Ona Mine on the Myakka and Peace River watersheds and on Charlotte Harbor is none to minor, which is not significant. The moderate (without mitigation) degree of effect on Horse Creek and minor degree of effect on the Peace River at Arcadia and Upper Myakka River are overwhelmed at this scale by the contributions of other tributaries, and over time by the predicted increases in flow due to changes in land use. These effects are described further in the No Action Alternative section above (4.2.1) and in the surface water resources cumulative effects section (4.12.2).

4.2.4 **Alternative 4: Wingate East Mine**

The proposed Wingate East Mine is located primarily in the Upper Myakka River subwatershed (90% - 3,280 acres) with an additional portion in the Horse Creek subwatershed (10% - 355 acres). The Wingate East Mine expansion is one-fifth the size of the Desoto Mine and one-sixth the size of the Ona Mine by comparison. This mine as proposed would use the CSAs, beneficiation plant, and mine infrastructure corridors of the existing Wingate Creek Mine. The Wingate East Mine anticipated schedule has mining to continue for the first 28 years of the mine operations, and reclamation to continue to mine year 41. Mosaic proposes to begin mining in this site in 2020; therefore, mining should be complete by 2048 and reclamation should be complete by 2061.

The capture area curve for the Wingate East Mine site is presented in Figure 4-5 and reflects the gradual increase in acreage included in the recirculation system boundary over the roughly 28-year period of active mining, with a gradual return of lands to contribute to downstream flows as reclamation rates exceed the mining rates and result in a net decrease in the capture area acreages. On the basis of this analysis, the peak years of capture are predicted to occur over most of the period of matrix extraction, after which reclamation and land release would gradually return the full mine footprint to contributing runoff to downstream waters. Approximately two-thirds of this mine is proposed to be mined using a dredge and the other third to be mined by draglines. Because the wet dredge process does not facilitate the storage of additional water onsite (because the pits are already full of water), it was assumed that only half as much capture of stormwater would occur with this alternative. Reductions in surface water from the mine capture were only applied at half the area shown on the capture curve for this mine, so effectively this alternative was analyzed at 25 and 50 percent capture, but the naming convention was not changed for discussion consistency in the AEIS. Like the dragline mines, the wet dredge scenarios with this changed assumption capture a much higher percentage of stormwater than the Applicants indicate that they would use in practice.

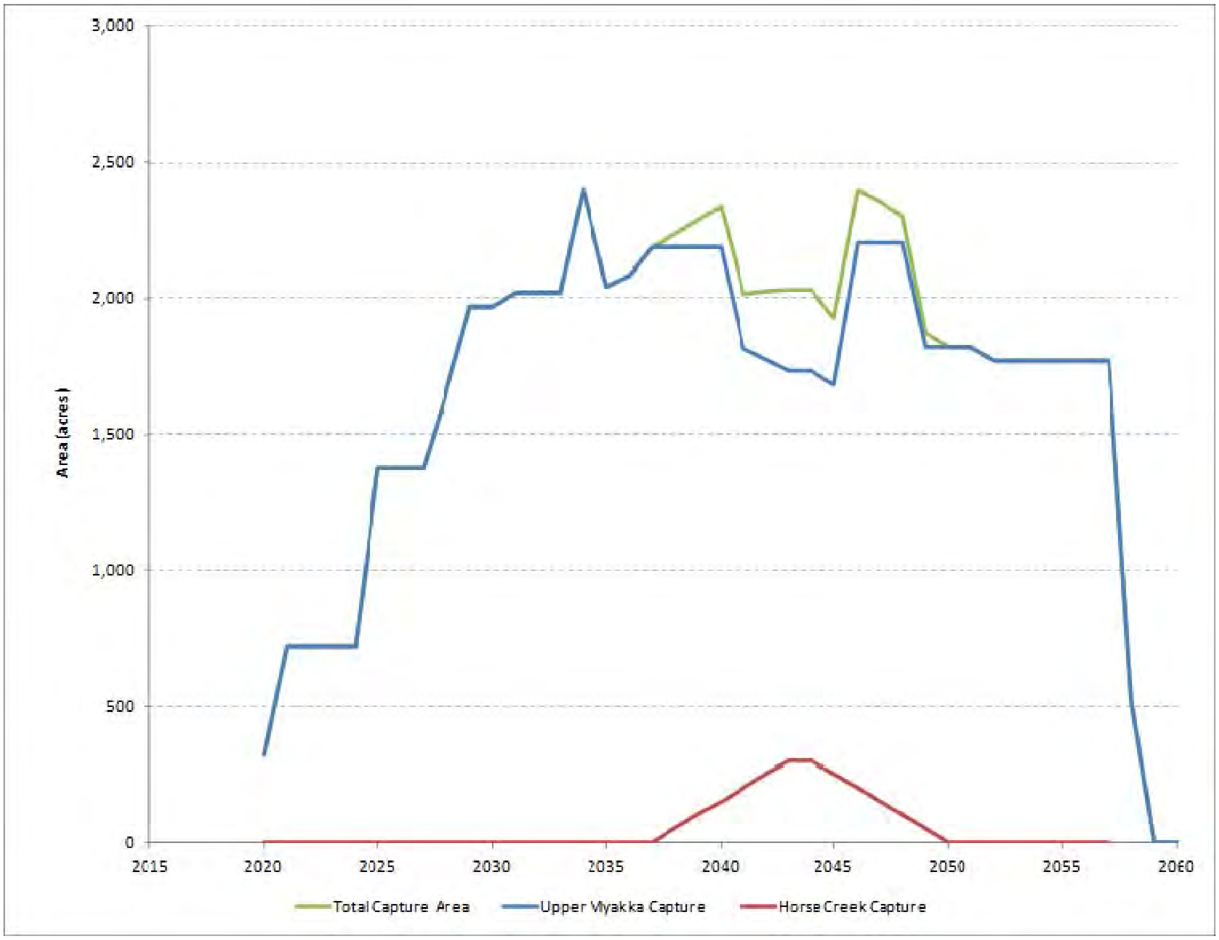

Figure 4-5. Wingate East Mine Stormwater Capture Area Graph

The mining sequence is reflected in the capture area and indicates that from 2025 to 2055, mining would occur in the Upper Myakka River subwatershed.

4.2.4.1 Wingate East Mine Effects on Horse Creek

The Wingate East Mine's potential impacts on the Horse Creek subwatershed were not calculated because of the very small size of the mine in this subwatershed. Approximately 355 acres of the Wingate East Mine are within the Horse Creek subwatershed. It is not expected that mining this relatively small percentage of the overall subwatershed would have a measurable effect on flows within the subwatershed.

4.2.4.2 Wingate East Mine Effects on Upper Myakka River

Tables 4-27 and 4-28 present the annual average and seasonal flows calculated for an average annual rainfall year for the Myakka River near Sarasota gage station with the Wingate East Mine for the 100 percent and 50 percent stormwater capture, respectively. Tables 4-29 and 4-30 present the annual average and seasonal flows calculated for a low rainfall year for the Myakka River near Sarasota gage station with the Wingate East Mine for the 100 percent and 50 percent stormwater capture, respectively.

The largest influence on streamflow from the Upper Myakka River subwatershed from the mining capture areas of the Wingate East Mine was predicted to occur from 2030 to 2050. When considering the condition of 100 percent capture, the Myakka River near Sarasota gage station may show an average annual flow of approximately 259 to 272 cfs without the Wingate East Mine, and approximately 257 to 271 cfs with the Wingate East Mine during average rainfall conditions. This corresponds to a decrease in flow of approximately 1 to 2 cfs, or less than 1 percent below the No Action Alternative conditions; and an increase in flow of approximately 14 to 28 cfs, or 6 to 11 percent above the calculated 2009 average annual flow of 243 cfs. When considering the 50 percent stormwater capture condition, the annual average flow from the Upper Myakka River subwatershed may be approximately 258 to 271 cfs with the Wingate East Mine during average rainfall conditions. This corresponds to a decrease in flow of approximately 1 cfs, less than 1 percent below the No Action Alternative conditions; and an increase in flow of approximately 14 to 28 cfs, or 6 to 11 percent above the calculated 2009 average annual flow. Flow increases from the 2009 levels can be attributed to predicted changes in land uses in this subwatershed. Changes to annual average flow from the Upper Myakka River subwatershed during average rainfall conditions were minimal and not likely detectable because of the relatively small area being mined in the Upper Myakka River subwatershed.

Table 4-27. Projected Flows and Percent Change from 2009 Flows during Average Rainfall Year and 100 Percent Capture at the Upper Myakka Flow Station with the Wingate East Mine

	Annual Average Flow (cfs)	Annual Average Percent Change from 2009 Flows	Dry Season Average Flow (cfs)	Dry Season Percent Change from 2009 Flows	Wet Season Average Flow (cfs)	Wet Season Percent Change from 2009 Flows
2009	243	0%	109	0%	589	0%
2020	251	3%	113	3%	607	3%
2030	257	6%	115	6%	620	5%
2040	264	8%	118	9%	635	8%
2050	271	11%	122	12%	652	11%
2060	279	15%	125	15%	671	14%

Table 4-28. Projected Flows and Percent Change from 2009 Flows during Average Rainfall Year and 50 Percent Capture at the Upper Myakka River Flow Station with the Wingate East Mine

	Annual Average Flow (cfs)	Annual Average Percent Change from 2009 Flows	Dry Season Average Flow (cfs)	Dry Season Percent Change from 2009 Flows	Wet Season Average Flow (cfs)	Wet Season Percent Change from 2009 Flows
2009	243	0%	113	0%	589	0%
2020	251	3%	113	0%	607	3%
2030	258	6%	116	2%	622	6%
2040	265	9%	119	5%	638	8%
2050	271	11%	122	8%	654	11%
2060	279	15%	125	11%	671	14%

The same evaluation was performed for a low rainfall year with similar results. Table 4-29 presents the flow and percent change from 2009 average annual and seasonal flows during a low rainfall year with 100 percent capture of stormwater in the capture area of the Myakka River near Sarasota gage station. When considering the condition of 100 percent capture of stormwater in the mining capture area of the Wingate East Mine from 2030 to 2050, the Upper Myakka River may have an average annual flow between approximately 210 and 221 cfs without the Wingate East Mine, and approximately 208 to 220 cfs with the Wingate East Mine during low rainfall conditions. This corresponds to a decrease in flow of less than one percent below the No Action Alternative conditions; and an increase in flow of approximately 11 to 23 cfs, or 6 to 11 percent of the calculated 2009 average annual flow of 197 cfs. When considering the 50 percent stormwater capture condition (Table 4-30), the difference in the effect to the annual average flow in the Upper Myakka River subwatershed was insubstantial.

Table 4-29. Projected Flows and Percent Change from 2009 Flows during Low Rainfall Year and 100 Percent Capture at the Upper Myakka River Flow Station with the Wingate East Mine

	Annual Average Flow (cfs)	Annual Average Percent Change from 2009 Flows	Dry Season Average Flow (cfs)	Dry Season Percent Change from 2009 Flows	Wet Season Average Flow (cfs)	Wet Season Percent Change from 2009 Flows
2009	197	0%	88	0%	478	0%
2020	204	3%	91	3%	492	3%
2030	208	6%	93	6%	503	5%
2040	214	8%	96	8%	516	8%
2050	220	11%	99	11%	529	11%
2060	226	15%	102	15%	544	14%

Table 4-30. Projected Flows and Percent Change from 2009 Flows during Low Rainfall Year and 50 Percent Capture at the Upper Myakka River Flow Station with the Wingate East Mine

	Annual Average Flow (cfs)	Annual Average Percent Change from 2009 Flows	Dry Season Average Flow (cfs)	Dry Season Percent Change from 2009 Flows	Wet Season Average Flow (cfs)	Wet Season Percent Change from 2009 Flows
2009	197	0%	88	0%	478	0%
2020	204	3%	91	3%	492	3%
2030	209	6%	94	6%	505	6%
2040	215	9%	96	9%	517	8%
2050	220	12%	99	12%	530	11%
2060	226	15%	102	15%	544	14%

4.2.4.3 Wingate East Mine: Degree and Significance of Surface Water Resource Effects

There is in effect no reduction to the stream flow resulting from the mining of Wingate East either on the Upper Myakka River subwatershed, the Myakka River watershed, or Charlotte Harbor, and no significant impact on the Horse Creek subwatershed. Therefore, the effect of this Alternative on streamflow within the subwatershed and watersheds is minor and is not significant.

4.2.5 **Alternative 5: South Pasture Extension Mine**

The proposed South Pasture Extension Mine is mostly in the Horse Creek subwatershed (71% - 5,324 acres), with additional areas in the Peace River at Arcadia (24% - 1,781 acres) and Payne Creek (5% - 409 acres) subwatersheds. CF Industries proposes to initially use the CSAs and mine infrastructure corridors of the South Pasture Mine. CF Industries proposes to begin mining into this extension in 2020 (although earlier completion of the existing mine would move this date forward). The South Pasture Extension Mine anticipated schedule describes mining to continue for the first 14 to 15 years of the mine operations, and reclamation to continue to mine year 26. CF Industries anticipates beginning mining at the South Pasture Extension Mine site in 2020; therefore, mining should be complete by 2034 and reclamation should be complete by 2046.

The capture area graph for the South Pasture Extension Mine is presented in Figure 4-6. CF and reflects the gradual increase in acreage included in the recirculation system boundary over the roughly 14-year period of active mining, with a gradual return of lands to contribute to downstream flows as reclamation rates exceed the mining rates and result in a net decrease in the capture area acreages. On the basis of this analysis, the peak years of capture are predicted to occur toward the end of the period of matrix extraction, after which reclamation and land release would gradually return the full mine footprint to contributing runoff to downstream waters.

4.2.5.1 South Pasture Extension Mine Effects on Payne Creek

An analysis was not conducted for the effect of the mining of 409 acres within the Payne Creek subwatershed. The Payne Creek subwatershed is 125 square miles in size, and on a percentage basis (about 64% of total subwatershed) is already the most heavily mined subwatershed in the Lower Peace River watershed. The Payne Creek watershed is similar sized to the Joshua Creek subwatershed and apparently discharges more water during low flows than would be anticipated for a watershed of its size based on a comparison with other Peace River subwatersheds (SWFWMD, 2005; Schreuder, 2006). Because of the relative size of the South Pasture Extension Mine proposed in Payne Creek subwatershed, it is not expected that mining this relatively small percentage of the overall subwatershed would have a measurable additional effect on flows within the subwatershed.

The mining sequence indicates that for the first 20 years of mining operations, mining would occur in the Horse Creek and Peace River at Arcadia subwatersheds concurrently.

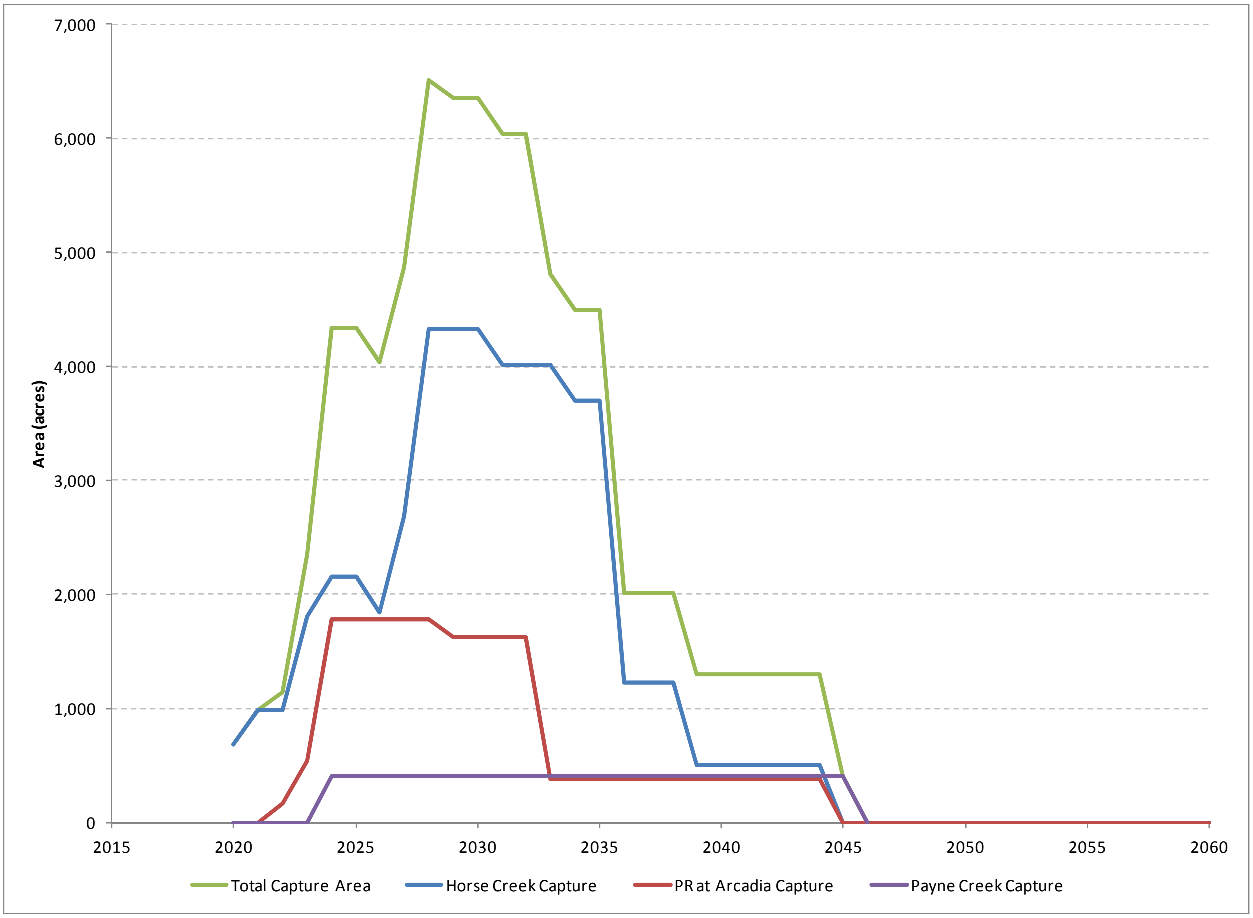

Figure 4-6. South Pasture Extension Mine Stormwater Capture Area Graph

4.2.5.2 South Pasture Extension Mine Effects on Horse Creek

Tables 4-31 and 4-32 present the annual average flows and seasonal flows calculated for Horse Creek for an average annual rainfall year with the South Pasture Extension Mine for the 100 percent and 50 percent stormwater capture, respectively. Tables 4-33 and 4-34 present the annual average flows and seasonal flows calculated for a low rainfall year for Horse Creek gage stations with the South Pasture Extension Mine for the 100 percent and 50 percent capture, respectively, for low rainfall conditions.

The largest influence on streamflow from the Horse Creek subwatershed from the mining capture areas of the South Pasture Extension Mine was predicted to show on the graphics in 2030. When considering the condition of 100 percent stormwater capture in 2030, Horse Creek may have an average annual flow of approximately 173 cfs without the South Pasture Extension Mine, and approximately 167 cfs with the South Pasture Extension Mine during average rainfall conditions. This corresponds to a decrease in flow of approximately 6 cfs, or 4 percent below the No Action Alternative conditions; and a decrease in flow of approximately 4 cfs, or 3 percent below the calculated 2009 average annual flow of 171 cfs. When considering the 50 percent stormwater capture condition, the annual average flow in Horse Creek may be approximately 170 cfs with the

South Pasture Extension Mine during average rainfall conditions. This corresponds to a decrease in flow of approximately 3 cfs, or 1 percent below the No Action Alternative conditions; and a decrease in flow of approximately 1 cfs, or less than 1 percent below the calculated 2009 average annual flow.

Table 4-31. Projected Flows and Percent Change from 2009 Flows during Average Rainfall Year and 100 Percent Capture at the Horse Creek Flow Station with the South Pasture Extension Mine

	Annual Average Flow (cfs)	Annual Average Percent Change from 2009 Flows	Dry Season Average Flow (cfs)	Dry Season Average Percent Change from 2009 Flows	Wet Season Average Flow (cfs)	Wet Season Average Percent Change from 2009 Flows
2009	171	0%	78	0%	404	0%
2020	172	0%	77	0%	411	2%
2030	167	-3%	75	-3%	401	-1%
2040	174	2%	78	1%	418	3%
2050	175	3%	79	2%	422	4%
2060	177	3%	79	2%	424	5%

Table 4-32. Projected Flows and Percent Change from 2009 Flows during Average Rainfall Year and 50 Percent Capture at the Horse Creek Flow Station with the South Pasture Extension Mine

	Annual Average Flow (cfs)	Annual Average Percent Change from 2009 Flows	Dry Season Average Flow (cfs)	Dry Season Average Percent Change from 2009 Flows	Wet Season Average Flow (cfs)	Wet Season Average Percent Change from 2009 Flows
2009	171	0%	78	0%	404	0%
2020	172	1%	78	0%	412	2%
2030	170	0%	76	-1%	409	1%
2040	174	2%	78	1%	418	3%
2050	175	3%	79	2%	422	4%
2060	177	3%	79	2%	424	5%

The same evaluation was performed for a low rainfall year. Tables 4-33 and 4-34 present the annual average flows and seasonal flows calculated for Horse Creek with the South Pasture Extension Mine for the 100 percent and 50 percent stormwater capture, respectively. When considering the condition of 100 percent capture of stormwater in the mining capture area of the South Pasture Extension Mine, Horse Creek may have an average annual flow of approximately 86 cfs without the South Pasture Extension Mine, and approximately 82 cfs with the South Pasture Extension Mine during low rainfall conditions. This corresponds to a decrease in flow of approximately 5 percent below the No Action Alternative conditions; and a decrease in flow of approximately 2 cfs, or 2 percent of the calculated 2009 average annual flow of 84 cfs. When considering the 50 percent stormwater capture condition (Table 4-34), the annual average flow in Horse Creek was reduced by a proportional percentage.

Table 4-33. Projected Flows and Percent Change from 2009 Flows during Low Rainfall Year and 100 Percent Capture at the Horse Creek Flow Station with the South Pasture Extension Mine

	Annual Average Flow (cfs)	Annual Average Percent Change from 2009 Flows	Dry Season Average Flow (cfs)	Dry Season Average Percent Change from 2009 Flows	Wet Season Average Flow (cfs)	Wet Season Average Percent Change from 2009 Flows
2009	84	0%	38	0%	199	0%
2020	84	0%	38	0%	202	2%
2030	82	-2%	37	-3%	197	-1%
2040	85	2%	38	1%	205	3%
2050	86	3%	39	2%	207	4%
2060	87	3%	39	2%	209	5%

Table 4-34. Projected Flows and Percent Change from 2009 Flows during Low Rainfall Year and 50 Percent Capture at the Horse Creek Flow Station with the South Pasture Extension Mine

	Annual Average Flow (cfs)	Annual Average Percent Change from 2009 Flows	Dry Season Average Flow (cfs)	Dry Season Average Percent Change from 2009 Flows	Wet Season Average Flow (cfs)	Wet Season Average Percent Change from 2009 Flows
2009	84	0%	38	0%	199	0%
2020	85	1%	38	0%	202	2%
2030	84	0%	38	-1%	201	1%
2040	86	2%	38	0%	206	3%
2050	86	3%	39	2%	207	4%
2060	87	3%	39	2%	209	5%

4.2.5.3 South Pasture Extension Mine Effects on Peace River at Arcadia

Tables 4-35 and 4-36 present the annual average flows and seasonal flows calculated for Peace River at Arcadia with the South Pasture Extension Mine for the 100 percent and 50 percent stormwater capture, respectively.

The largest influence on streamflow from the Peace River at Arcadia subwatershed from the mining capture areas of the South Pasture Extension Mine was predicted to occur around 2030. However, the impact to annual average flow from the Peace River at Arcadia subwatershed during average rainfall conditions was minimal and likely not detectable because of the small area being impacted in the Peace River at Arcadia subwatershed. When considering the condition of 100 percent capture of stormwater in the mining capture area of the South Pasture Extension Mine, Peace River at Arcadia may have an average annual flow of approximately 738 cfs without the South Pasture Extension Mine in 2030, and approximately the same flow with the South Pasture Extension Mine during average rainfall conditions in the same years. These are identical to the flows predicted for the No Action Alternative. This predicted flow is an increase in flow of approximately 25 cfs, or 3 percent above the calculated 2009 average annual flow of 713 cfs. Flow increases from the 2009 levels can be attributed to predicted changes in land uses in this subwatershed. The 50 percent capture scenario also has a negligible effect in this subwatershed.

Table 4-35. Projected Flows and Percent Change from 2009 Flows during Average Rainfall Year and 100 Percent Capture at the Peace River at Arcadia Flow Station with the South Pasture Extension Mine

	Annual Average Flow (cfs)	Annual Average Percent Change from 2009 Flows	Dry Season Average Flow (cfs)	Dry Season Average Percent Change from 2009 Flows	Wet Season Average Flow (cfs)	Wet Season Average Percent Change from 2009 Flows
2009	713	0%	328	0%	1,657	0%
2020	726	2%	332	1%	1,702	3%
2030	738	3%	336	3%	1,740	5%
2040	754	6%	343	5%	1,785	8%
2050	772	8%	351	7%	1,829	10%
2060	783	10%	355	8%	1,858	12%

Table 4-36. Projected Flows and Percent Change from 2009 Flows during Average Rainfall Year and 50 Percent Capture at the Peace River at Arcadia Flow Station with the South Pasture Extension Mine

	Annual Average Flow (cfs)	Annual Average Percent Change from 2009 Flows	Dry Season Average Flow (cfs)	Dry Season Average Percent Change from 2009 Flows	Wet Season Average Flow (cfs)	Wet Season Average Percent Change from 2009 Flows
2009	713	0%	328	0%	1,657	0%
2020	726	2%	332	1%	1,702	3%
2030	738	3%	336	2%	1,741	5%
2040	754	6%	343	5%	1,785	8%
2050	772	8%	351	7%	1,829	10%
2060	783	10%	355	8%	1,858	12%

The same evaluation was performed for a low rainfall year. Tables 4-37 and 4-38 present the annual average flows and seasonal flows calculated for a low rainfall year with the South Pasture Extension Mine for the 100 percent and 50 percent stormwater capture, respectively. Changes in flows are indistinguishable from the No Action Alternative.

Table 4-37. Projected Flows and Percent Change from 2009 Flows during Low Rainfall Year and 100 Percent Capture at the Peace River at Arcadia Flow Station with the South Pasture Extension Mine

	Annual Average Flow (cfs)	Annual Average Percent Change from 2009 Flows	Dry Season Average Flow (cfs)	Dry Season Average Percent Change from 2009 Flows	Wet Season Average Flow (cfs)	Wet Season Average Percent Change from 2009 Flows
2009	330	0%	152	0%	766	0%
2020	337	2%	154	1%	787	3%
2030	342	4%	156	3%	806	5%
2040	350	6%	159	5%	827	8%
2050	358	9%	163	7%	848	11%
2060	363	10%	165	9%	862	13%

Table 4-38. Projected Flows and Percent Change from 2009 Flows during Low Rainfall Year and 50 Percent Capture at the Peace River at Arcadia Flow Station with the South Pasture Extension Mine

	Annual Average Flow (cfs)	Annual Average Percent Change from 2009 Flows	Dry Season Average Flow (cfs)	Dry Season Average Percent Change from 2009 Flows	Wet Season Average Flow (cfs)	Wet Season Average Percent Change from 2009 Flows
2009	330	0%	152	0%	766	0%
2020	337	2%	154	1%	787	3%
2030	342	4%	156	3%	806	5%
2040	350	6%	159	5%	827	8%
2050	358	9%	163	7%	848	11%
2060	363	10%	165	9%	862	13%

4.2.5.4 South Pasture Extension Mine: Degree and Significance of Surface Water Resource Effects

While the flow rate from mining is projected to decrease up to 3 percent for the Horse Creek subwatershed during an average rainfall year or a low rainfall year in the dry season with a 100 percent capture area, the decrease in flow rates falls within the accuracy range for this analysis which is based on an extremely variable parameter (rainfall). The reduction in flows within Horse Creek may be indicative of a change at the Horse Creek subwatershed level; therefore, the effect cannot be considered minor. For a major effect, there must be an extended effect on surface water flows at least at the subwatershed level that also leads to a violation of the MFLs for the subwatershed. In addition to the potential reductions being within one order of significant figures, there are no SWFWMD MFLs established for Horse Creek to which the flow reduction can be compared. For this reason (no contribution to a violation of MFLs for Horse Creek and a change in stream flow rates that falls within the accuracy range), the effect on surface water flows within Horse Creek cannot be considered to have a major effect. The apparent reduction in flow is indicative of a change beyond the boundaries of the mine within the Horse Creek subwatershed even though the degree may be within the realm of natural variation. Therefore, the effects would be moderate without mitigation within the Horse Creek subwatershed but reduced to minor with mitigation. Given the moderate level of an effect for this mine within the watershed, the effect is expected to be significant without mitigation and not significant with mitigation.

Possible measures that would reduce the moderate degree of effect, mitigate the intensity factors, and potentially make the effects not significant include recharge ditches and wells to maintain base flow in Horse Creek and its tributaries, or reducing the capture area. There are also monitoring program and other provisions in FDEP mining permits. If it is determined through monitoring that there is an unanticipated impact to the creek, the Applicants would need to address those impacts.

The effects within the Payne Creek and Peace River at Arcadia subwatersheds are minor to no effect and are not considered significant.

The individual effect of the South Pasture Extension Mine on the Peace River watershed and on Charlotte Harbor is none to minor, which is not significant. The moderate (without mitigation) degree of effect on Horse Creek and minor degree of effect on the Peace River at Arcadia and Payne Creek are overwhelmed at this scale by the contributions of other tributaries, and over time by the predicted increases in flow due to changes in land use. These effects are described further in the No Action Alternative section above (4.2.1) and in the surface water resources cumulative effects section (4.12.2).

4.2.6 **Alternative 6: Pine Level/Keys Tract**

The Pine Level/Keys Tract is in the Lower Myakka/Big Slough subwatershed (84% - 20,727 acres) of the Lower Myakka River watershed, the Upper Myakka River subwatershed (2% - 499 acres), and the Horse Creek subwatershed (14% - 3,484 acres). This site was identified by Mosaic as a future mine extension to the Desoto Mine; however, this mine is also a potential offsite alternative to the Applicants' Preferred Alternatives and was evaluated as an individual alternative in this section. Under cumulative impact analysis presented in Section 4.12.2, the Pine Level/Keys Tract is considered a reasonably foreseeable action. For the purpose of the description of impacts presented in this section, where the Pine Level/Keys Tract is a stand-alone alternative to the Applicants' Preferred Alternatives, this mine would require construction of an initial CSA, a beneficiation plant, and initial mine infrastructure corridors. The start date of mining was assumed to be 2025, mining would continue into mine year 32 (2057) and reclamation would continue until approximately mine year 40 (2065).

The capture area curve for the Pine Level/Keys Tract Mine site is presented in Figure 4-7 and reflects the gradual increase in acreage included in the recirculation system boundary over the roughly 32-year period of active mining, with a gradual return of lands to contribute to downstream flows as reclamation rates exceed the mining rates and result in a net decrease in the capture area acreages. On the basis of this analysis, the peak years of capture are predicted to occur toward the end of the period of matrix extraction, after which reclamation and land release would gradually return the full mine footprint to contributing runoff to downstream waters. The Lower Myakka/Big Slough subwatershed drains toward the City of North Port and Myakkahatchee Creek, which joins the Myakka River very near where it flows into Charlotte Harbor. Therefore, this mine's drainage area would not influence flows in the Myakka River except as they contribute to Charlotte Harbor (for the cumulative effect analysis in Section 4.12).

4.2.6.1 Pine Level/Keys Tract Effects on Upper Myakka River

The Pine Level/Keys Tract's potential impacts on the Upper Myakka River subwatershed were not calculated because of the very small size of the mine (approximately 499 acres) in this subwatershed. It is not expected that mining this relatively small percentage of the overall subwatershed would have a measurable effect on flows within the subwatershed.

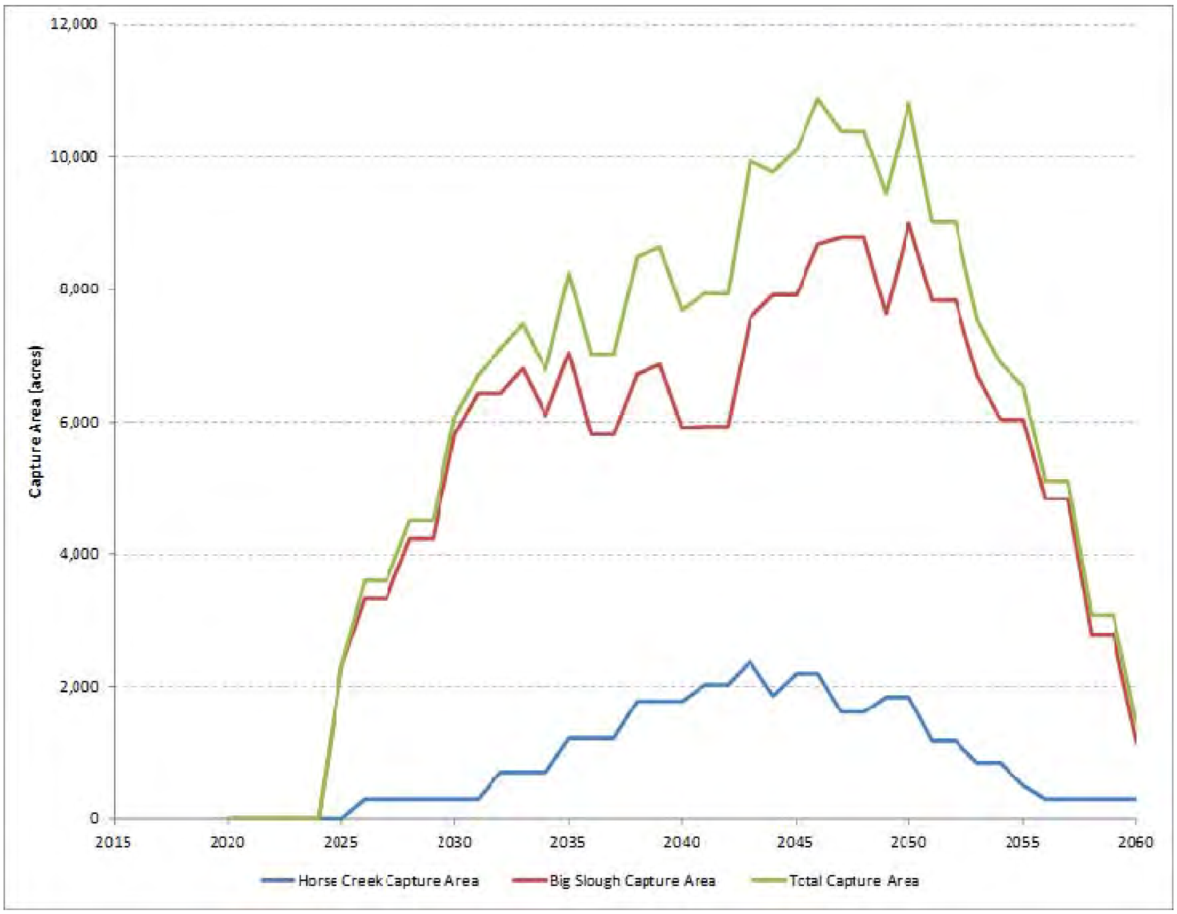

Figure 4-7. Pine Level/Keys Tract Mine Stormwater Capture Area Graph

4.2.6.2 Pine Level/Keys Tract Effects on Lower Myakka/Big Slough

Tables 4-39 and 4-40 present the annual average and seasonal flow rates calculated for an average annual rainfall for the Lower Myakka/Big Slough subwatershed with the Pine Level/Keys Tract for the 100 percent and 50 percent stormwater capture, respectively. Tables 4-41 and 4-42 present the annual average and seasonal flow rates calculated for a low annual rainfall for the Lower Myakka/Big Slough subwatershed with the Pine Level/Keys Tract for the 100 percent and 50 percent stormwater capture, respectively.

The largest influence on streamflow on the Lower Myakka/Big Slough subwatershed from the mining capture areas of the Pine Level/Keys Tract alternative was predicted to occur in approximately 2050 based on the capture graph. When considering the most conservative capture condition, 100 percent stormwater capture, the Lower Myakka/Big Slough subwatershed may have an average annual flow of approximately 217 cfs without the Pine Level/Keys Tract, and approximately 203 cfs with the Pine Level/Keys Tract during average rainfall conditions. This corresponds to a decrease in flow of approximately 14 cfs, or 6 percent below the No Action Alternative conditions as well as the calculated 2009 average annual flow of 217 cfs. When considering the 50 percent capture condition, the annual average flow from the Upper Myakka River subwatershed may be approximately 210 cfs with the Pine Level/Keys Tract during average rainfall conditions. This corresponds to a decrease in flow of approximately 7 cfs, or 3 percent below the No Action Alternative conditions as well as the calculated 2009 average annual flow. Unlike the other alternatives studied, there is no change in the annual flow rates predicted over time in Lower Myakka/Big Slough in this analysis because, unlike the other subwatersheds, there were no resulting changes to future land use. There was no projected increase in urbanization or other mines that would be reclaimed in the upper reaches of the subwatershed. As the mines are reclaimed, the flows return to near pre-mining conditions.

Table 4-39. Projected Flows and Percent Change from 2009 Flows during Average Rainfall Year and 100 Percent Capture in Lower Myakka/Big Slough Watershed with the Pine Level/Keys Tract

	Annual Average Flow (cfs)	Annual Average Percent Change from 2009 Flows	Dry Season Average Flow (cfs)	Dry Season Percent Change from 2009 Flows	Wet Season Average Flow (cfs)	Wet Season Percent Change from 2009 Flows
2009	217	0%	117	0%	629	0%
2020	217	0%	117	0%	629	0%
2030	206	-5%	111	-5%	596	-5%
2040	207	-5%	111	-5%	599	-5%
2050	203	-6%	109	-7%	589	-6%
2060	215	-1%	116	-1%	623	-1%

Table 4-40. Projected Flows and Percent Change from 2009 Flows during Average Rainfall Year and 50 Percent Capture in Lower Myakka/Big Slough Subwatershed with the Pine Level/Keys Tract

	Annual Average Flow (cfs)	Annual Average Percent Change from 2009 Flows	Dry Season Average Flow (cfs)	Dry Season Percent Change from 2009 Flows	Wet Season Average Flow (cfs)	Wet Season Percent Change from 2009 Flows
2009	217	0%	117	0%	629	0%
2020	217	0%	117	0%	629	0%
2030	212	-3%	114	-3%	614	-3%
2040	212	-2%	113	-3%	609	-2%
2050	210	-3%	112	-4%	601	-3%
2060	216	<-1%	116	<-1%	626	<-1%

The same evaluation was performed for a low rainfall year with similar results. Table 4-41 presents the flow and percent change from 2009 average annual and seasonal flows during a low rainfall year with 100 percent capture of stormwater in the capture area of the Pine Level/Keys Tract. Table 4-42 presents the flow and percent change from 2009 average annual and seasonal flows during a low rainfall year with 50 percent capture of stormwater in the capture area of the Pine Level/Keys Tract. The maximum influence is predicted to occur in approximately 2050 based on the capture analysis. When considering the condition of 100 percent capture of stormwater in the mining capture area of the Pine Level/Keys Tract Mine, Lower Myakka/Big Slough may have an average annual flow of approximately 176 cfs without the Pine Level/Keys Tract Mine, and approximately 165 cfs with the Pine Level/Keys Tract during low rainfall conditions. This corresponds to a decrease by approximately 6 percent by 2050 from the No Action Alternative. When considering the 50 percent stormwater capture condition (Table 4-42), the annual average flow decreases by approximately 2 percent by 2050, less than half of the 100 percent capture scenario from the No Action Alternative or from the 2009 levels.

Table 4-41. Projected Flows and Percent Change from 2009 Flows during Low Rainfall Year and 100 Percent Capture in Lower Myakka/Big Slough Subwatershed with the Pine Level/Keys Tract

	Annual Average Flow (cfs)	Annual Average Percent Change from 2009 Flows	Dry Season Average Flow (cfs)	Dry Season Percent Change from 2009 Flows	Wet Season Average Flow (cfs)	Wet Season Percent Change from 2009 Flows
2009	176	0%	95	0%	511	0%
2020	176	0%	95	0%	511	0%
2030	167	-5%	90	-5%	484	-5%
2040	168	-5%	90	-5%	486	-5%
2050	165	-6%	89	-7%	478	-6%
2060	175	-1%	94	-1%	506	-1%

Table 4-42. Projected Flows and Percent Change from 2009 Flows during Low Rainfall Year and 50 Percent Lower Myakka/Big Slough Subwatershed with the Pine Level/Keys Tract

	Annual Average Flow (cfs)	Annual Average Percent Change from 2009 Flows	Dry Season Average Flow (cfs)	Dry Season Percent Change from 2009 Flows	Wet Season Average Flow (cfs)	Wet Season Percent Change from 2009 Flows
2009	176	0%	95	0%	511	0%
2020	176	0%	95	0%	511	0%
2030	172	-3%	92	-3%	497	-3%
2040	172	-2%	92	-2%	498	-2%
2050	169	-4%	91	-3%	494	-3%
2060	175	-1%	94	<-1%	508	<-1%

4.2.6.3 Pine Level/Keys Tract Effect on Horse Creek

Tables 4-43 and 4-44 present the annual average flows and seasonal flows calculated for an average rainfall year with the Pine Level/Keys Tract for the 100 percent and 50 percent stormwater capture, respectively. The largest influence on streamflow on the Horse Creek subwatershed from the mining capture areas of the Pine Level/Keys Tract alternative was predicted to occur between 2040 and 2050 based on the capture graph. When considering the condition of 100 percent stormwater capture between 2040 and 2050, Horse Creek may have an average annual flow of approximately 174 cfs without the Pine

Level/Keys Tract, and approximately 173 cfs with the Pine Level/Keys Tract during average rainfall conditions. This corresponds to a decrease in flow of approximately 1 cfs, or less than 1 percent below the No Action Alternative conditions; and an increase in flow of approximately 2 cfs, or 1 percent above the calculated 2009 average annual flow of 171 cfs. Flow increases from the 2009 levels can be attributed to predicted changes in land uses in this subwatershed. The 50 percent capture scenario also has a negligible effect in this subwatershed.

Table 4-43. Projected Flows and Percent Change from 2009 Flows during Average Rainfall Year and 100 Percent Capture in Horse Creek with the Pine Level/Keys Tract

	Annual Average Flow (cfs)	Annual Average Percent Change from 2009 Flows	Dry Season Average Flow (cfs)	Dry Season Percent Change from 2009 Flows	Wet Season Average Flow (cfs)	Wet Season Percent Change from 2009 Flows
2009	171	0%	78	0%	404	0%
2020	173	1%	78	0%	413	2%
2030	173	1%	78	0%	416	3%
2040	172	1%	77	<1%	414	2%
2050	173	1%	78	0%	417	3%
2060	176	3%	79	2%	424	5%

Table 4-44. Projected Flows and Percent Change from 2009 Flows during Average Rainfall Year and 50 Percent Capture in Horse Creek with the Pine Level/Keys Tract

	Annual Average Flow (cfs)	Annual Average Percent Change from 2009 Flows	Dry Season Average Flow (cfs)	Dry Season Percent Change from 2009 Flows	Wet Season Average Flow (cfs)	Wet Season Percent Change from 2009 Flows
2009	171	0%	78	0%	404	0%
2020	173	1%	78	0%	413	2%
2030	173	1%	78	0%	416	3%
2040	173	1%	78	0%	417	3%
2050	174	2%	78	<1%	419	4%
2060	176	3%	79	2%	424	5%

The same evaluation was performed for a low rainfall year. Tables 4-45 and 4-46 present the annual average flows and seasonal flows calculated for a low rainfall year with the Pine Level/Keys Tract for the 100 percent and 50 percent stormwater capture, respectively. Changes in flows are insignificantly different from the No Action Alternative (1 cfs or less).

Table 4-45. Projected Flows and Percent Change from 2009 Flows during Low Rainfall Year and 100 Percent Capture in Horse Creek with the Pine Level/Keys Tract

	Annual Average Flow (cfs)	Annual Average Percent Change from 2009 Flows	Dry Season Average Flow (cfs)	Dry Season Percent Change from 2009 Flows	Wet Season Average Flow (cfs)	Wet Season Percent Change from 2009 Flows
2009	84	0%	38	0%	199	0%
2020	85	1%	38	0%	203	2%
2030	85	1%	38	0%	204	3%
2040	85	1%	38	0%	204	2%
2050	85	1%	38	0%	205	3%
2060	87	3%	39	2%	208	5%

Table 4-46. Projected Flows and Percent Change from 2009 Flows during Low Rainfall Year and 50 Percent in Horse Creek with the Pine Level/Keys Tract

	Annual Average Flow (cfs)	Annual Average Percent Change from 2009 Flows	Dry Season Average Flow (cfs)	Dry Season Percent Change from 2009 Flows	Wet Season Average Flow (cfs)	Wet Season Percent Change from 2009 Flows
2009	84	0%	38	0%	199	0%
2020	85	1%	38	0%	203	2%
2030	85	1%	38	0%	204	3%
2040	85	1%	38	0%	205	3%
2050	86	2%	39	1%	206	4%
2060	87	3%	39	2%	208	5%

4.2.6.4 Pine Level/Keys Tract: Degree and Significance of Surface Water Resource Effects

Within the Lower Myakka/Big Slough subwatershed, while the flow rate from mining is projected to decrease up to 7 percent in 2050 during the dry seasonal flow with a 100 percent capture area regardless of the rainfall levels, the decrease in flow rates falls within the error range for this analysis which is based on an extremely variable parameter (rainfall). The reduction in flows within Lower Myakka/Big Slough subwatershed may be indicative of a change at the Lower Myakka/Big Slough subwatershed level; therefore, the effect cannot be considered minor. For a major effect, there must be an extended effect on surface water flows at least at the subwatershed level that also leads to a violation of the MFLs for the subwatershed. In addition to the potential reductions being within one order of significant figures, there are no SWFWMD MFLs established for Lower Myakka/Big Slough subwatershed to which flow reductions can be compared. For this reason (no contribution to a violation of MFLs for Lower Myakka/Big Slough and a change in stream flow rates that falls within the expected error range), the effect on surface water flows within Lower Myakka/Big Slough subwatershed cannot be considered to have a major effect. The apparent reduction in flow is indicative of a change beyond the boundaries of the mine within the Lower Myakka/Big Slough subwatershed even though the degree may be within the realm of natural variation. Therefore, the effects would be moderate without mitigation within the Lower Myakka/Big Slough subwatershed. Given the moderate level of an effect for this mine within the watershed, the effect is expected to be significant.

For the Horse Creek subwatershed, the maximum predicted impacts on flow rate from mining are decreases of less than 1 percent in 2040 during the dry seasonal flow in an average rainfall year with a 100 percent capture area, and less than 1 percent in 2050 during the dry seasonal flow in an average rainfall year with a 50 percent capture area. Flow increases from the 2009 levels predicted at the end of the temporal scope of the analysis can be attributed to predicted changes in land uses in this subwatershed and they exceed reductions predicted for this alternative's impact in Horse Creek. Although measurable, the adverse effects are at a very low level, and therefore are determined to be minor and not significant

The effect within the Upper Myakka subwatershed is a minor to no effect and is not considered significant. The individual effect of mining the Pine Level/Keys Tract on the Myakka River and Peace River watersheds and on Charlotte Harbor is none to minor, which is not significant. The moderate (without mitigation) degree of effect on Lower Myakka/Big Slough and Horse Creek and minor degree of effect on the Upper Myakka River are overwhelmed at this scale by the contributions of other tributaries, and over time by the predicted increases in flow due to changes in land use. These effects are described further in the No Action Alternative section above (4.2.1) and in the surface water resources cumulative effects section (Section 4.12.2).

Possible measures that would reduce the moderate degree of effect, mitigate the intensity factors, and potentially make the effects not significant include recharge ditches and wells to maintain base flow in the Lower Myakka/Big Slough and Horse Creek subwatersheds and their tributaries, or reducing the capture area within the two subwatersheds. There are also monitoring programs and other provisions in FDEP mining permits. If it were determined through monitoring that there were unanticipated impacts in either subwatershed, the Applicants would need to address those impacts.

4.2.7 **Alternative 7: Pioneer Tract**

The Pioneer Tract is in the Horse Creek subwatershed (43% - 10,824 acres) and the Peace River at Arcadia subwatershed (57% - 14,426 acres). This site was identified by Mosaic as a future mine extension to the Ona Mine; however, this mine is also a reasonable alternative to the Applicants' Preferred Alternatives and will be evaluated as an individual alternative in this section. Under cumulative impact analysis presented in Section 4.12, the Pioneer Tract is considered a reasonably foreseeable action. For the purpose of the description of impacts presented in this section, where the Pioneer Tract is a standalone alternative to the Applicants' Preferred Alternatives, this mine would require construction of an initial CSA, a beneficiation plant, and initial mine infrastructure corridors. The start date of mining was assumed to be 2025, mining would continue into mine year 32 (2057) and reclamation would continue until approximately mine year 40 (2065).

The capture area curve for the Pioneer Tract Mine site is presented In Figure 4-8 and reflects the gradual increase in acreage included in the recirculation system boundary over the roughly 32-year period of active mining, with a gradual return of lands to contribute to downstream flows as reclamation rates exceed the mining rates and result in a net decrease in the capture area acreages. As with the previous alternatives where the footprint lies in different subwatersheds, the analysis provides the results by subwatershed. The impacts of this alternative on surface water runoff potential were calculated by evaluating the change to the runoff coefficients in the Horse Creek and the Peace River at Arcadia subwatersheds. On the basis of this analysis, the peak years of capture are predicted to occur toward the end of the period of matrix extraction, after which reclamation and land release would gradually return the full mine footprint to contributing runoff to downstream waters.

4.2.7.1 Pioneer Tract Effects on Horse Creek

Tables 4-47 and 4-48 present the annual average and seasonal flow rates calculated for Horse Creek with Pioneer Mine for an average rainfall year for the 100 percent and 50 percent stormwater capture, respectively. Tables 4-49 and 4-50 present the annual average and seasonal flow rates calculated for Horse Creek with Pioneer Mine for a low rainfall year for the 100 percent and 50 percent stormwater capture, respectively.

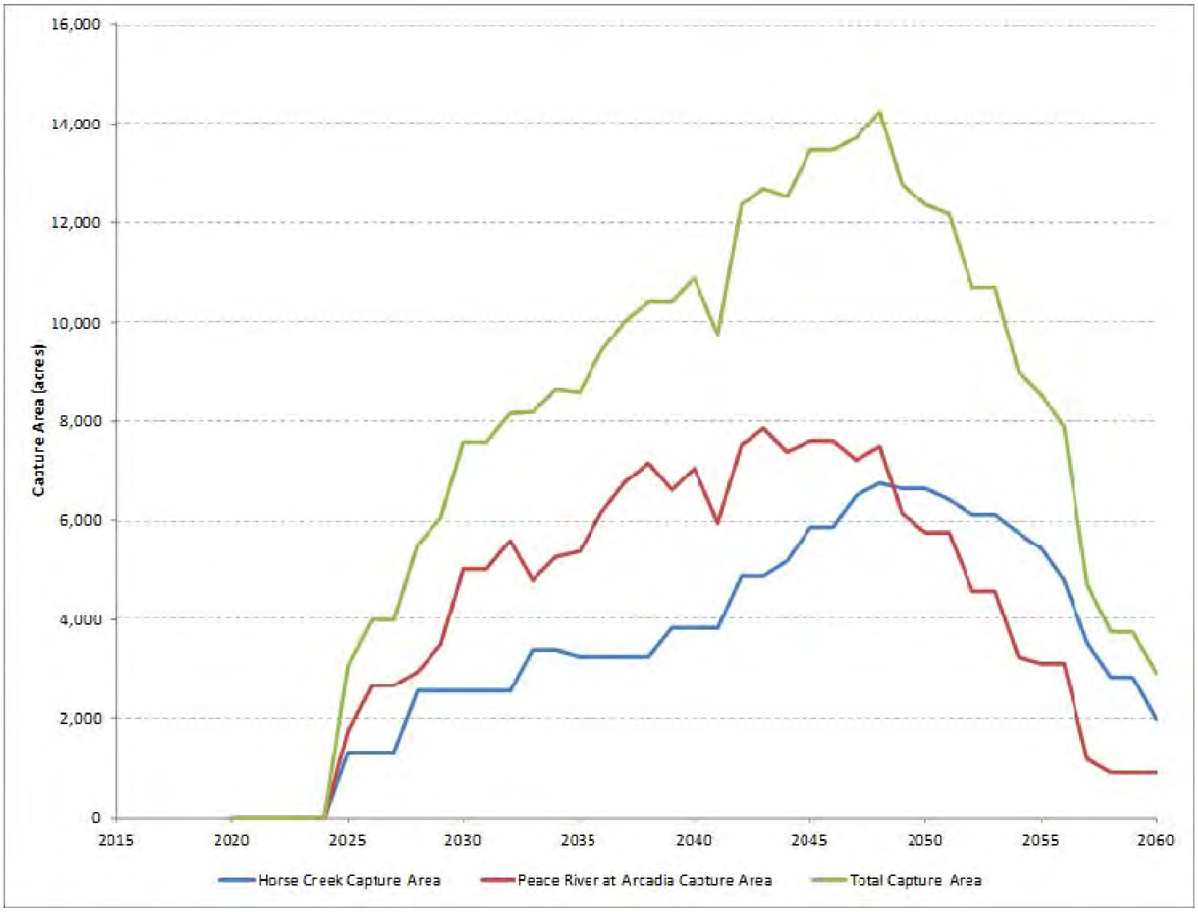

Figure 4-8. Stormwater Capture Area Graph for a Conceptual Pioneer Tract

Table 4-47. Projected Flows and Percent Change from 2009 Flows during Average Rainfall Year and 100 Percent Capture at the Horse Creek Flow Station with the Pioneer Tract

	Annual Average Flow (cfs)	Annual Average Percent Change from 2009 Flows	Dry Season Average Flow (cfs)	Dry Season Average Percent Change from 2009 Flows	Wet Season Average Flow (cfs)	Wet Season Average Percent Change from 2009 Flows
2009	171	0%	78	0%	404	0%
2020	173	1%	78	0%	413	2%
2030	170	-1%	76	-2%	408	1%
2040	169	-1%	76	-2%	407	1%
2050	165	-3%	74	-4%	400	-1%
2060	174	2%	78	1%	418	3%

Table 4-48. Projected Flows and Percent Change from 2009 Flows during Average Rainfall Year and 50 Percent Capture at the Horse Creek Flow Station with the Pioneer Tract

	Annual Average Flow (cfs)	Annual Average Percent Change from 2009 Flows	Dry Season Average Flow (cfs)	Dry Season Average Percent Change from 2009 Flows	Wet Season Average Flow (cfs)	Wet Season Average Percent Change from 2009 Flows
2009	171	0%	78	0%	404	0%
2020	173	1%	78	0%	413	2%
2030	172	<1%	77	-1%	412	2%
2040	172	1%	77	-1%	413	2%
2050	171	0%	77	-1%	411	2%
2060	175	2%	79	1%	421	4%

Table 4-49. Projected Flows and Percent Change from 2009 Flows during Low Rainfall Year and 100 Percent Capture at the Horse Creek Flow Station with the Pioneer Tract

	Annual Average Flow (cfs)	Annual Average Percent Change from 2009 Flows	Dry Season Average Flow (cfs)	Dry Season Average Percent Change from 2009 Flows	Wet Season Average Flow (cfs)	Wet Season Average Percent Change from 2009 Flows
2009	84	0%	38	0%	199	0%
2020	85	1%	38	0%	203	2%
2030	83	-1%	38	-2%	201	1%
2040	83	-1%	37	-2%	200	1%
2050	82	-3%	37	-4%	197	-1%
2060	85	2%	38	1%	205	3%

Table 4-50. Projected Flows and Percent Change from 2009 Flows during Low Rainfall Year and 50 Percent Capture at the Horse Creek Flow Station with the Pioneer Tract

	Annual Average Flow (cfs)	Annual Average Percent Change from 2009 Flows	Dry Season Average Flow (cfs)	Dry Season Average Percent Change from 2009 Flows	Wet Season Average Flow (cfs)	Wet Season Average Percent Change from 2009 Flows
2009	84	0%	38	0%	199	0%
2020	85	1%	38	0%	203	2%
2030	84	0%	38	<-1%	203	2%
2040	84	<1%	38	<-1%	203	2%
2050	84	0%	38	<-1%	202	2%
2060	86	2%	39	1%	207	4%

The largest influence on streamflow from the Horse Creek subwatershed from the mining capture areas of the Pioneer Tract in the Horse Creek subwatershed was predicted to occur in approximately 2050 based on the capture graph. When considering the most conservative runoff capture condition, 100 percent stormwater capture, in 2050 Horse Creek may have an average annual flow of approximately 175 cfs without the Pioneer Tract, and approximately 165 cfs with the Pioneer Tract during average rainfall conditions. This corresponds to a decrease in flow of approximately 10 cfs, or 6 percent below the No Action Alternative conditions; and a decrease in flow of approximately 6 cfs, or 3 percent below the calculated 2009 average annual flow of 171 cfs. When considering the 50 percent stormwater capture condition, the annual average flow in Horse Creek may be approximately 171 cfs with the Pioneer Tract during average rainfall conditions. This corresponds to a decrease in flow of approximately 4 cfs, or 2 percent below the No Action Alternative conditions; and about the same flow as the calculated 2009 average annual flow. Flow increases from the 2009 levels can be attributed to predicted changes in land uses in areas of this subwatershed. Flow is expected to return to near No Action Alternative conditions by 2060 and is slightly higher than 2009 flow because changes to land use outweigh the effects of mining.

The same evaluation was performed for a low rainfall year. Tables 4-49 and 4-50 present the flow and percent change from 2009 average annual and seasonal flows during a low rainfall year with 100 and 50 percent capture of stormwater in the capture area of the Pioneer Tract at the Horse Creek flow station, respectively. Similar to the average rainfall conditions evaluation, annual average flow does not change by much. The average annual flow for the 100 percent capture scenario with an average annual rainfall decreases by approximately 3 percent by 2050 when compared to 2009 flows. The flows recover after 2050 to a level that is higher than the 2009 levels resulting from land use change. All differences in this case are only a few cfs. Considering the low rainfall year with a capture area of 50 percent and the changes are negligible.

4.2.7.2 Pioneer Tract Effects on Peace River at Arcadia

Tables 4-51 and 4-52 present the annual average flows and seasonal flow rates calculated in an average rainfall year for Peace River at Arcadia gage stations with the Desoto Mine for the 100 percent and 50 percent stormwater capture, respectively. Tables 4-53 and 4-54 present the annual average flows and seasonal flow rates calculated in a low rainfall year for Peace River at Arcadia gage stations with the Desoto Mine for the 100 percent and 50 percent stormwater capture, respectively.

The largest influence on streamflow from the Peace River at Arcadia subwatershed from the mining capture areas of the Pioneer Tract was predicted to occur on 2040. When considering the condition of 100 percent stormwater capture, Peace River at Arcadia may have an average annual flow of approximately 754 cfs without the Pioneer Tract in 2040, and approximately 749 cfs with the Pioneer Tract during average rainfall conditions in the same year (Table 4-36). This corresponds to a decrease in flow of approximately 5 cfs, or less than 1 percent below the No Action Alternative conditions; and an increase in flow of approximately 36 cfs, or 5 percent above the calculated 2009 average annual flow. When considering the 50 percent stormwater capture condition, the results are very similar to those estimated under the 100 percent capture conditions (Table 4-37). The impact to annual average flow from the Peace River at Arcadia subwatershed during average rainfall conditions was minimal and likely not detectable because although the acreage of the mining (over 14,000 acres) within the subwatershed is large, a comparatively small area of the subwatershed is impacted and the flow within the subwatershed is high. Comparing this mine to the Desoto Mine in the Horse Creek subwatershed illustrates that point. The Desoto Mine has a similar acreage (15,993 versus 14,426), while the subwatershed flow in the Horse Creek is 171 cfs compared to 713 cfs for Peace River at Arcadia based on the 2009 levels, yet the Desoto Mine had no more than about a 9 cfs change. Based on land use changes within the subwatershed and upstream subwatersheds, flows are predicted to increase during the Pioneer Tract mining period in excess of the effect observed by mining.

Table 4-51. Projected Flows and Percent Change from 2009 Flows during Average Rainfall Year and 100 Percent Capture at the Peace River at Arcadia Flow Station with the Pioneer Tract

	Annual Average Flow (cfs)	Annual Average Percent Change from 2009 Flows	Dry Season Average Flow (cfs)	Dry Season Average Percent Change from 2009 Flows	Wet Season Average Flow (cfs)	Wet Season Average Percent Change from 2009 Flows
2009	713	0%	328	0%	1,657	0%
2020	726	2%	332	1%	1,702	3%
2030	734	3%	334	2%	1,734	5%
2040	749	5%	340	4%	1,773	7%
2050	768	8%	348	6%	1,818	10%
2060	782	10%	355	8%	1,856	12%

Table 4-52. Projected Flows and Percent Change from 2009 Flows during Average Rainfall Year and 50 Percent Capture at the Peace River at Arcadia Flow Station with the Pioneer Tract

	Annual Average Flow (cfs)	Annual Average Percent Change from 2009 Flows	Dry Season Average Flow (cfs)	Dry Season Average Percent Change from 2009 Flows	Wet Season Average Flow (cfs)	Wet Season Average Percent Change from 2009 Flows
2009	713	0%	328	0%	1,657	0%
2020	726	2%	332	1%	1,702	3%
2030	736	3%	335	2%	1,738	5%
2040	752	5%	341	4%	1,779	7%
2050	770	8%	349	7%	1,824	10%
2060	783	10%	355	8%	1,857	12%

The same evaluation was performed for a low rainfall year. Flows are predicted to decrease by less than one percent from the No Action Alternative by 2040. Annual average flow increases by approximately 5 percent by 2040 from 2009 levels. Under the 50 percent capture scenario, the difference from the 100 percent results is inconsequential.

Table 4-53. Projected Flows and Percent Change from 2009 Flows during Low Rainfall Year and 100 Percent Capture at the Peace River at Arcadia Flow Station with the Pioneer Tract

	Annual Average Flow (cfs)	Annual Average Percent Change from 2009 Flows	Dry Season Average Flow (cfs)	Dry Season Average Percent Change from 2009 Flows	Wet Season Average Flow (cfs)	Wet Season Average Percent Change from 2009 Flows
2009	330	0%	152	0%	766	0%
2020	337	2%	154	1%	787	3%
2030	340	3%	155	2%	803	5%
2040	347	5%	158	4%	822	7%
2050	357	8%	162	7%	845	10%
2060	363	10%	165	8%	861	12%

Table 4-54. Projected Flows and Percent Change from 2009 Flows during Low Rainfall Year and 50 Percent Capture at the Peace River at Arcadia Flow Station with the Pioneer Tract

	Annual Average Flow (cfs)	Annual Average Percent Change from 2009 Flows	Dry Season Average Flow (cfs)	Dry Season Average Percent Change from 2009 Flows	Wet Season Average Flow (cfs)	Wet Season Average Percent Change from 2009 Flows
2009	330	0%	152	0%	766	0%
2020	337	2%	154	1%	787	3%
2030	341	3%	155	2%	805	5%
2040	349	6%	158	4%	825	8%
2050	358	8%	162	7%	846	11%
2060	363	10%	165	9%	861	12%

4.2.7.3 Pioneer Tract: Degree and Significance of Surface Water Resource Effects

While the flow rate from mining in the Horse Creek subwatershed is projected to decrease up to 4 percent in 2050 from the seasonal dry flows with a 100 percent capture area for the average annual rainfall, the decrease in flow rates falls within the error range for this analysis which is based on an extremely variable parameter (rainfall). The reduction in flows within Horse Creek may be indicative of a change at the Horse Creek subwatershed level; therefore, the effect cannot be considered minor. For a major effect, there must be an extended effect on surface water flows at least at the subwatershed level that also leads to a violation of the MFLs for the subwatershed. In addition to the potential reductions being within one order of significant figures, there are no SWFWMD MFLs established for Horse Creek to which flow reductions can be compared. For this reason (no contribution to a violation of MFLs for Horse Creek and a change in stream flow rates that falls within the expected error range), the effect on surface water flows within Horse Creek cannot be considered to have a major effect. The apparent reduction in flow is indicative of a change beyond the boundaries of the mine within the Horse Creek subwatershed even though the degree may be within the realm of natural variation. Therefore, the effects would be moderate without mitigation within the Horse Creek subwatershed and minor with mitigation. Given the moderate level of an effect for this mine within the watershed, the effect is expected to be significant without mitigation but not significant with mitigation.

Possible measures that would reduce the moderate degree of effect, mitigate the intensity factors, and potentially make the effects not significant include recharge ditches and wells to maintain base flow in Horse Creek and its tributaries, or reducing the capture area. There are also monitoring program and other provisions in FDEP mining permits. If it is determined through monitoring that there is an unanticipated impact to the creek, the Applicants would need to address those impacts.

The effects within the Peace River at Arcadia subwatershed are minor to no effect and are not considered significant.

The individual effect of mining the Pioneer Tract on the Peace River watershed and on Charlotte Harbor is none to minor, which is not significant. The moderate (without mitigation) degree of effect on Horse Creek and minor degree of effect on the Peace River at Arcadia are overwhelmed at this scale by the contributions of other tributaries, and over time by the predicted increases in flow due to changes in land use. These effects are described further in the No Action Alternative section above (4.2.1) and in the surface water resources cumulative effects section (Section 4.12.2).

4.2.8 Alternative 8: Site A-2

Approximately 8,125 acres of Site A-2 is mapped within the Peace River at Zolfo Springs subwatershed. An additional 64 acres is mapped within the Charlie Creek subwatershed. The area mapped within the Charlie Creek subwatershed may be attributed to mapping inaccuracy, so the entire parcel will be considered within the Peace River at Zolfo Springs subwatershed. This section qualitatively describes the potential impact associated with mining Site A-2, based on the parcel having conditions affecting surface water contributions that are similar to those existing on the other offsite alternative parcels. No applicant has proposed mining Site A-2, and therefore there is not enough information available to perform a quantitative analysis.

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Appendix C:
Replacement Pages for Appendix J

Impact Evaluation Methods for the Final AEIS on Phosphate Mining in the CFPD

PREPARED FOR: U.S. Army Corps of Engineers, Jacksonville District

COPY TO: U.S. Environmental Protection Agency
Florida Department of Environmental Protection

PREPARED BY: CH2M HILL

DATE: April 9, 2013; revised June 25, 2013

PROJECT NUMBER: 418237.09.01

1.0 Introduction

Impact evaluations for each of the alternatives were often performed using publically available geographic information system (GIS) databases and supplementary data from the four applications for the Applicants' Preferred Alternatives plus the four offsite alternatives. Mosaic also provided some additional information about the Pine Level/Keys and Pioneer offsite alternatives. Relevant literature and information provided by the public during the scoping and Draft Areawide Environmental Impact Statement (DAEIS) comment periods further added to the database. Additional evaluations that went beyond GIS review, as described in the following sections, were performed for surface water resources, groundwater resources, ecological resources (including fish and wildlife habitats), and economic resources. Offsite alternatives were part of the evaluation, but because of the lack of site-specific, ground-truthed information about these sites and a lack of site-specific mine plans for these alternatives, their impact on resources was largely inferred based on current mining practices and proposed mining operations for the Applicants' Preferred Alternatives. The offsite alternatives A-2 and W-2 were the most speculative of the four offsite alternatives and had even less available data, which further limited the evaluation for some resource categories.

2.0 Surface Water Quantity Evaluation Methods

Evaluation of the potential effects of phosphate mining alternatives on surface water resources within the AEIS study area focused on addressing concerns that the expansion of mining could result in reduced quantities and quality of surface water to downstream reaches of streams and rivers, and to the Charlotte Harbor estuary. Reduced surface water flow and/or quality caused by a single mine or as a cumulative impact from multiple activities, including mining as well as other water users, could result in impacts to downstream aquatic biological communities, wildlife habitat, listed species, wetlands, recreational activities, or public water supplies. This section describes the methods used to assess the surface water quantity, while the next section describes water quality analysis methods.

The surface water quantity evaluation for the Final AEIS included modifications to address public comments, although the overall methodology to predict surface water flow from the landscape was similar in the Draft and Final AEIS. The stormwater capture curves were mostly the same in both analyses with minor adjustment of the Pine Level/Keys Tract boundary provided by Mosaic as a GIS shape file after publishing the Draft AEIS. The capture curves were adjusted to better align with subwatershed boundaries. The runoff coefficient approach was retained to estimate seasonal surface water delivery from the subwatersheds, but projected land uses in previously mined areas (extractive land use) that had been modified provided a better assessment of the impacts from reclamation and release of the existing mines.

Evaluations added to the Final AEIS to address comments on the Draft AEIS included an analysis of 50 percent capture of stormwater on active mined lands. This additional analysis provides an evaluation of average capture rates that are closer to information available from the Applicants' water use permit (WUP) applications. This 50 percent capture scenario is still very conservative but the 100 percent scenario evaluated in the Draft AEIS was also retained to provide an even more conservative bounding analysis approach. Surface water computations and results were updated to incorporate these changes.

New excess precipitation (Excess P) computations for active mine blocks were developed for the Final AEIS with the new 50 percent capture scenario for the Desoto, Ona, and South Pasture Extension alternatives. This 50 percent capture analysis was used in the groundwater modeling to determine the recharge rates at the Applicants' Preferred Alternatives. The results of the Excess P calculations compared well to the runoff coefficient approach results for the average annual rainfall.

A new low-flow analysis near the existing Peace River/Manasota Regional Water Supply Authority (PRMRWSA) intake was added to perform a bounding analysis of potential surface water supply impacts. However, there were insufficient data to conduct a comparable assessment at the City of North Port's intake location. In addition, this Final AEIS includes more definitions, assumptions, and explanations in Chapter 4 and Appendix G to address public comments and to add clarification to the document.

Information on the proposed durations and schedules of mining were available for each of the four Applicants' Preferred Alternatives: Desoto Mine, Ona Mine, Wingate East Mine, and South Pasture Mine Extension. Two of the four offsite alternatives (Pine Level/Keys Tract and Pioneer Tract) were considered reasonably foreseeable and likely to occur in the timeframe of the AEIS, based on their being likely extensions of the Desoto and Ona Mines, respectively. Therefore, conceptual mine plans were prepared for these two offsite alternatives based on information on site boundaries provided by Mosaic and assumptions based on other similarly sized mines for which mine plans were available. In considering these two offsite alternatives as independent mines to either of the Applicants' Preferred Alternatives, the scheduled implementation of these offsite alternatives would be moved up in time but the magnitude of their impact on surface water flow would be similar to that indicated by their evaluation as extensions to other mines.

The other two offsite alternatives (Sites A-2 and W-2) are more speculative since there has been no apparent interest by the Applicants to date in their future use. As a result, mine plans and site-specific information on potential mining activities are not available for these alternatives. Additional details on potential mining activities would be required before site-specific impact analyses could be completed. Therefore, rather than perform detailed modeling analyses, evaluations of these additional offsite alternatives are based on extrapolation, applying results from other analyses to the extent practical, using information on the size of the site, its location, existing land use, and other readily available information.

The temporal scope of the direct and indirect impacts analysis for each alternative is for the life of the mine operations, including reclamation, or through 2060. The Pine Level/Keys and Pioneer Tracts are considered both as individual mines as well as extensions to other mines under a cumulative impact analysis. The timeframe for these mines vary in each case: as an independent mine alternative, it is assumed they would start in 2025 and extend to about 2060; as extensions to other alternative mines, they would start after these host mines closed and extend beyond the year 2060. But no analyses are considered beyond a 50-year timeframe since the mines included under the Applicants' Preferred Alternatives would all be closed by that date.

The locations of the Applicants' Preferred Alternatives in relation to the Peace River and Myakka River watersheds and specific subwatersheds within the overall river watersheds are shown in Figures 1 and 2. Of the four Applicants' Preferred Alternatives, three are primarily in the Horse Creek subwatershed, with smaller areas in the Peace River at Arcadia subwatershed (Desoto Mine, Ona Mine, and South Pasture Mine Extension) and one (Wingate East Mine) is primarily in the Upper Myakka River subwatershed. One of the four offsite alternatives (Pioneer Tract) is similarly aligned within the Horse Creek and Peace River at Arcadia subwatersheds (about equally split between them), and a second (Pine Level/Keys Tract) is primarily in the Big Slough subwatershed in the Lower Myakka River subwatershed with a fraction located in Horse Creek. Because the Big Slough Basin is the only waterbody in the Lower Myakka River subwatershed affected by any of the alternatives considered, these are treated together as the Big Slough/Lower Myakka Subwatershed.

FIGURE 1

Location of the Alternatives in Relation to Peace River Subwatersheds

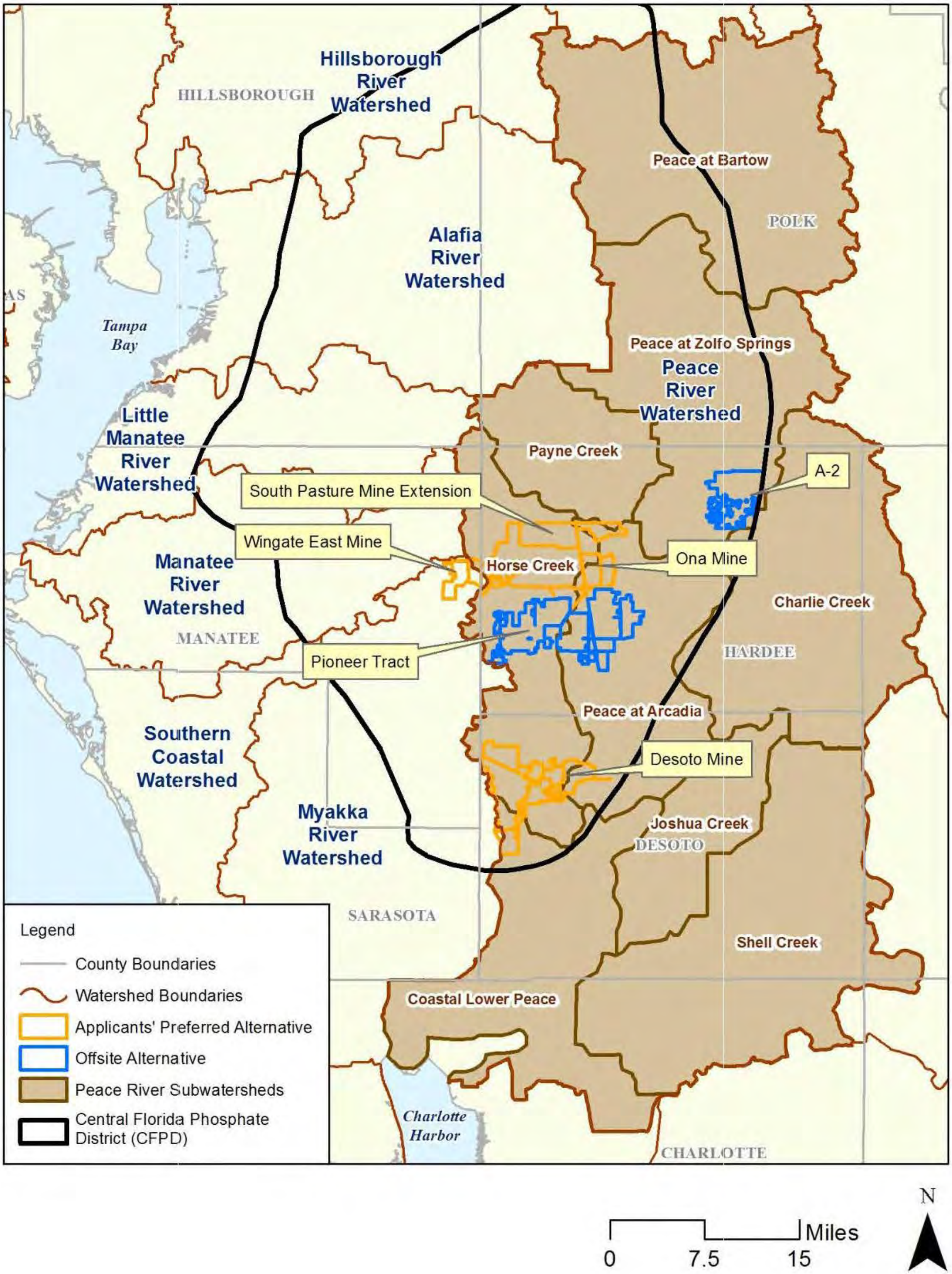
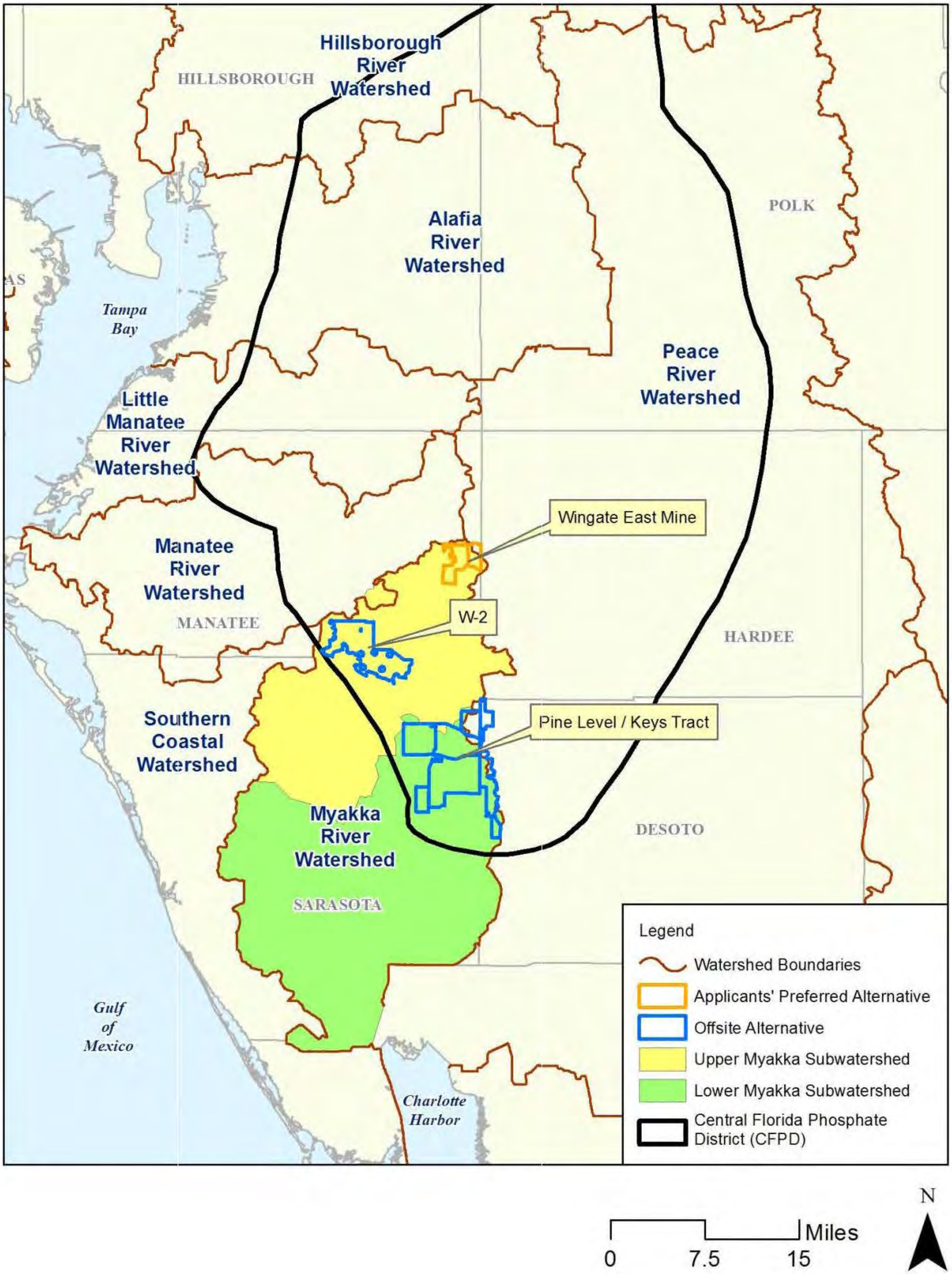


FIGURE 2
Location of the Alternatives in the Myakka River Subwatersheds



Accordingly, this surface water hydrologic analysis primarily focused on these three specific subwatersheds (Horse Creek and Peace River at Arcadia in the Peace River watershed and the Big Slough/Lower Myakka in the Myakka River watershed) within the AEIS study area, and subsequently to Charlotte Harbor estuary. The other two offsite alternatives are in the Peace River at Zolfo Springs (Site A-2) and the Upper Myakka River (Site W-2) subwatersheds. As discussed previously, analyses of these two offsite alternatives were qualitatively conducted for surface water direct and indirect impacts. Some of the alternatives also had smaller areas overlapping the subwatershed boundaries as defined by federal water resource agencies (U.S. Geological Survey [USGS] and U.S. Department of Agriculture [USDA]), and these are addressed as appropriate. The subwatershed boundaries and alternative boundaries do not always coincide in the GIS database. Furthermore, the landscapes at the upland boundaries are typically flat and some historic flow paths have been altered by ditching. This leaves some portions around the subwatershed boundary uncertain as to where runoff may flow. Very small areas and some larger areas, which are identified in the analysis, were considered insignificant because it was determined that the expected impact of an area of 500 acres or less would be less than 1 cubic foot per second (cfs) on an average annual basis. All flows were rounded to the nearest cfs, so small changes in flow would not be significant at the subwatershed scale.

During the ore extraction phase of phosphate mining (i.e., active mining), much of the direct rainfall on a given mine area is captured and held within a mine's recirculation system, consisting of a network of open-channel ditches and canals, clay settling area (CSA) impoundments, and a network of pipelines used for conveyance of water, matrix, sand, and clay slurries. Following capture, the stormwater is used and reused to support these conveyances and other onsite treatment and mitigation functions, with excess rainfall being released through National Pollutant Discharge Elimination System (NPDES) permitted outfalls or seeped into the surrounding surficial aquifer system (SAS) to hydrate adjacent wetlands and streams. For the AEIS, the direct impact of capturing the stormwater onsite at proposed mines was represented by capture area curves (area of mine included in the recirculation system at any given time). The reuse of onsite stormwater was a recommendation by the U.S. Environmental Protection Agency (USEPA) in their 1978 EIS for the phosphate industry as a way of reducing groundwater withdrawals (USEPA, 1978b).

The offsite, indirect impacts required a reasonable quantification of the potential reductions in offsite flow rates during active mining to evaluate the reduction of runoff to downstream resources that may occur on a long-term average basis. Following reclamation and the release of blocks of land from the control systems, the reclaimed land use responds hydrologically closer to pre-mining conditions (see Appendix G). The following section includes a description of the evaluation method and assumptions used in the AEIS for surface water flow estimates.

The AEIS had to support detailed assessment of the potential impacts on net downstream water deliveries for the subwatersheds affected by the Applicants' Preferred Alternatives and the offsite alternatives in various stages of mining and reclamation and for the overall river watersheds far into the future. The surface water effect of the No Action Alternative also had to be assessed. The methodology applied to assess surface water runoff changes had to meet the following goals:

- Account for runoff differences between different soils and land uses
- Support analysis of affected subwatersheds as well as the overall river watersheds where the subject mines are located
- Account for a seasonal component since central Florida has distinct dry and wet seasons
- Account for changes in land use, including mining, far into the future (to 2060) with reasonable accuracy and sensitivity

A review of available methods and computer models is provided in Appendix G. In summary, no detailed hydrologic computer simulation models have been developed for the entire study area that could be readily applied without significant expense and lengthy work. Detailed hydrologic computer modeling of short-term relationships was not viewed as an appropriate technical approach to support the AEIS evaluations. Rather, a simpler method was used that would provide long-range predictions that account for changes in land use over time both within the mine footprint as well as for the subwatersheds where the mines are located.

2.1 Runoff Calculation Method Overview

The approach adopted to estimate the offsite surface water delivery is based on the one used for a recent analysis of pollutant loading to the Charlotte Harbor estuary performed on behalf of the Charlotte Harbor National Estuary Program (CHNEP) by Janicki (2010). The evaluations conducted for the CHNEP coupled the hydraulic evaluations of watershed runoff with water quality information to generate pollutant load estimates. For the AEIS evaluations, the method adopted was based on the hydraulic component of the overall pollutant loading analysis.

Runoff amounts resulting from the rainfall on the land not in the Applicants' Preferred Alternatives were calculated taking into account a combination of factors, including watershed and subwatershed boundaries (acreages), land uses, and soil hydrologic groups. The combination of land use and soil types was used to develop land use-specific runoff coefficients.

For any given watershed, the flow for a given seasonal or annual period can be calculated by applying the equation:

$$Q = C_D * A * P * j * k$$

This equation is part of a pollutant loading method sometimes called the USEPA Simple Method, and it is often used to predict annual runoff for pollutant loading estimates. For this equation:

Q is the flow in cfs

C_D is the runoff coefficient for the contributing subwatershed

A is the drainage area that contributes flow to the gaged location

P is the total precipitation during the analysis frequency (annual or seasonal)

j is the long-term hydrologic adjustment factor

k is a factor applied for units conversion

The USGS maintains flow recording gages near the downstream ends of each of the major subwatersheds identified in Figures 1 and 2. To calculate seasonal and annual flows in the subwatersheds at the USGS gage stations, the subwatershed-level runoff calculation method was calibrated to the AEIS subwatersheds of interest in the Peace and Myakka Rivers. This was done by using historical rainfall records and GIS-based data for subwatershed boundaries (and subwatershed acreage), soil hydrologic types, land use information, and land use-specific runoff coefficients developed by Janicki (2010) for land areas tributary to the Charlotte Harbor estuary. The referenced long-term hydrologic adjustment factor was used for calibration of this runoff assessment approach to the specific subwatersheds in the study area. In general, j is used to account for a variety of influences on the retention and storage volume within a watershed (for example, either in lakes and reservoirs or in the subsurface soil layers) and it varies between subwatersheds and with annual rainfall amount (i.e., wet year or season versus dry year or season).

This analytical method was tested against USGS gaged flows within the Peace River and Myakka River subwatersheds to validate this empirical approach for the AEIS evaluations. Detailed information on the data used to support method development and the results of method validation analysis are presented in Appendix G. Figures 3 and 4 reflect the method validation demonstration. The discharge calculations generated through this land-use based runoff assessment method closely matched the measured flows based on the applicable USGS gage records. In general, the accuracy of predicting average annual flow rates at the subwatershed level (i.e., at the USGS gages) was about the same as reported for studies with more detailed computer modeling. Using the long-term adjustment factor as a calibration factor for the runoff coefficient water balance approach provided reasonable results when compared to measured flow records. By calibrating these coefficients to observed flow data, the past and present indirect impacts of mining on subwatershed surface water yield are implicitly included in the baseline 2010 conditions.

FIGURE 3
Calculated and Measured Flows at the Horse Creek USGS Gage

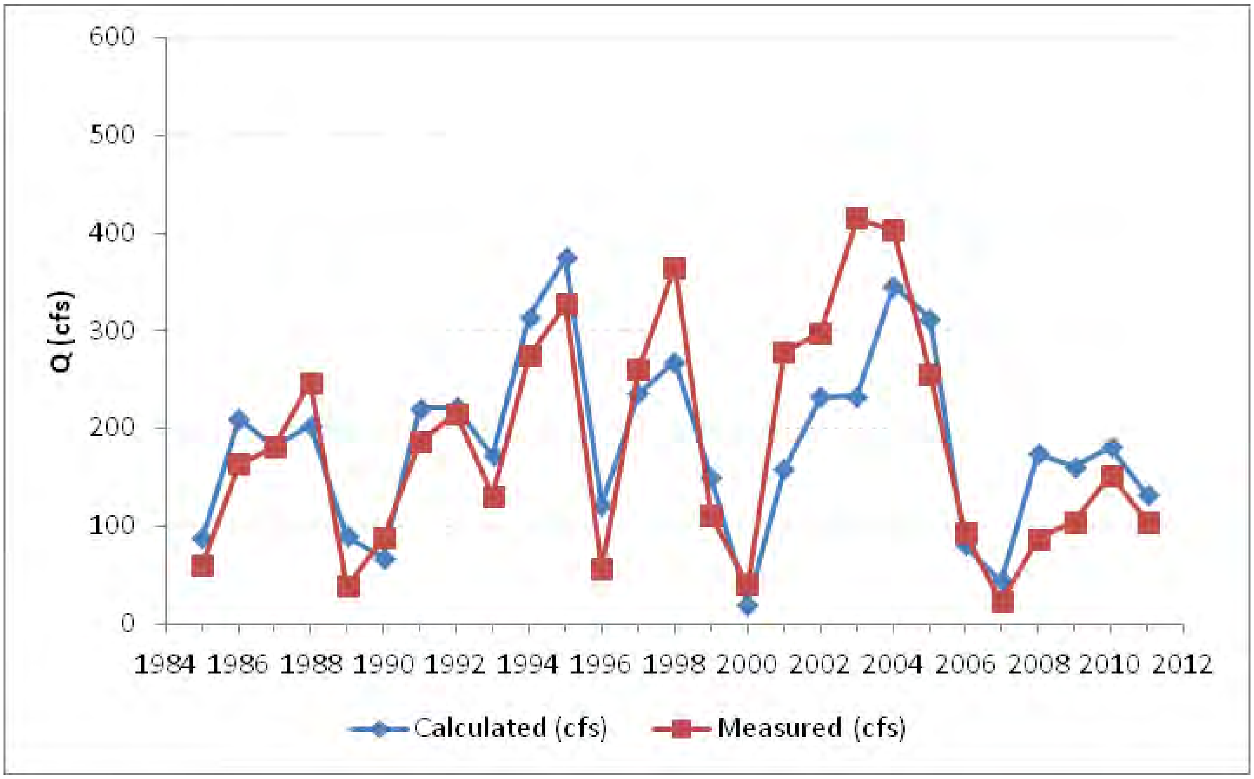
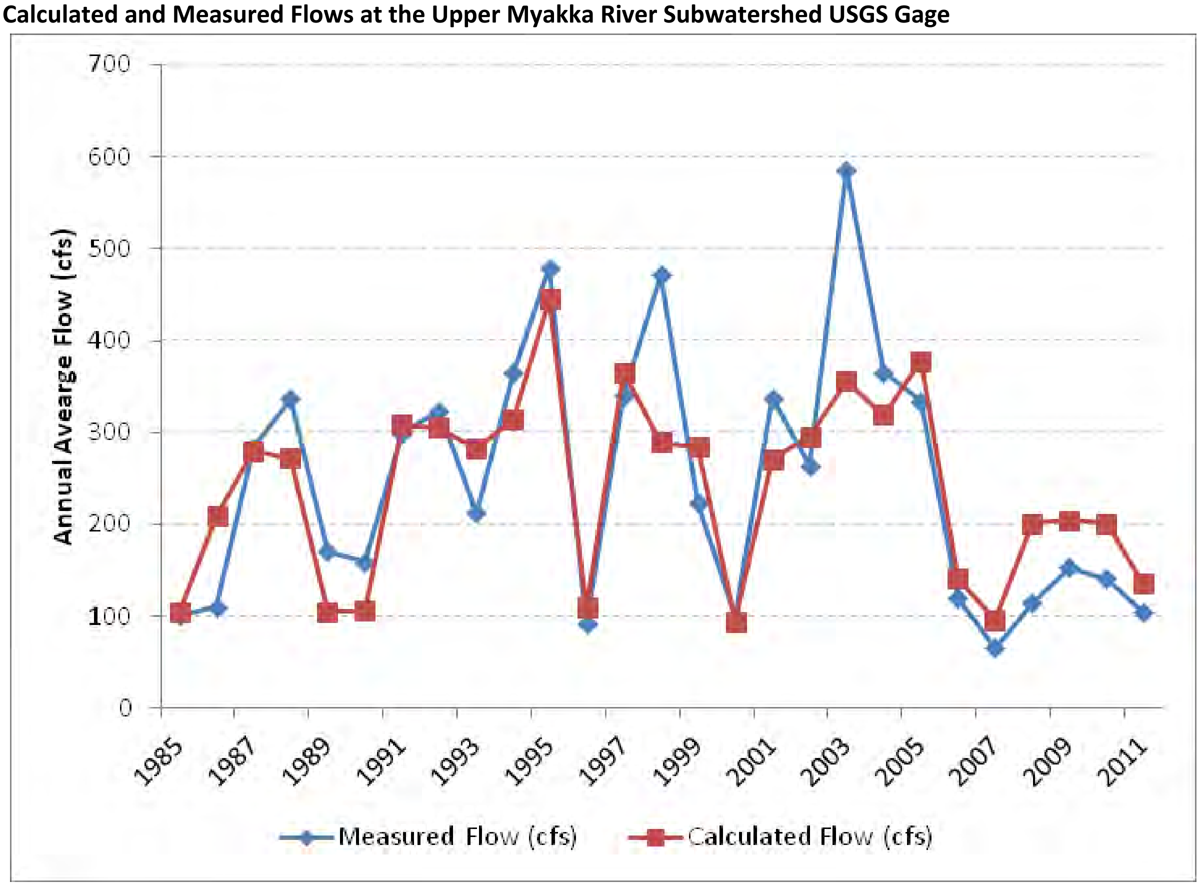


FIGURE 4
Calculated and Measured Flows at the Upper Myakka River Subwatershed USGS Gage



2.2 Key Assumptions Supporting Surface Water Runoff Analyses

Several key assumptions were applied during the surface water evaluations. Because stormwater runoff from natural land is associated with land use, future land use was estimated based on long-term trends and the available information about the existing mines. The No Action Alternative was estimated assuming that no new future mining would be initiated, even though some upland mining could occur if permits were denied and the Applicants modified their applications to avoid jurisdictional wetlands and surface waters. This assumption is conservative for the No Action Alternative because higher surface water flows would be predicted in the future if no additional mining area is captured. If there were mining in uplands only, then the downstream No Action Alternative flows would be somewhat higher because essentially the areas in the capture curves would likewise be smaller. Consequently, the greatest computed impact from the No Action Alternative would be to assume no future mining in these subwatersheds.

Existing mines were assumed to complete mining on schedule and their reclaimed land was assumed to return to predominantly agricultural land use. Additional information about the basis for these computations is provided in Appendix G.

One key assumption was that the current practice of using ditch and berm systems would continue at all mine alternatives to prevent uncontrolled offsite runoff from the active mining area to offsite lands, and also to support capture and retention of surface water within the mine's recirculation system to conserve groundwater and to help hydrate surrounding surficial groundwater. The capture of stormwater at mine sites and the controlled release through outfalls permitted as industrial point source discharges (NPDES) is a regulatory requirement.

Mosaic and CF Industries have included specific features designed to maintain the levels in the surrounding surficial aquifers during mining. The baseflow component and the post-reclamation conditions are addressed by USEPA regulations published at Title 40, Code of Federal Regulations, Part 436.180 (40 CFR 436.180) requiring Mosaic and CF Industries to construct a berm around the perimeter of active mining and reclamation areas to capture stormwater to preclude nonpoint discharges of turbid water and resulting water quality violations. Mosaic and CF Industries design their perimeter ditch and berm systems to contain the runoff generated by a 25-year, 24-hour storm event (Florida Department of Environmental Protection [FDEP], 2006c). Water captured in the ditches adjacent to the berms is routed to CSAs for quiescent settling of solids and subsequent water reuse in the mining process, or is discharged through an outfall permitted under Section 402 of the Clean Water Act (an NPDES permit). Use of this water quality treatment system creates the potential for changes in overland flow to streams as well as the timing of flows, or the stream hydrographs. Mosaic and CF Industries are proposing to site a series of permitted outfalls adjacent to surface waters on or near project boundaries. Use of multiple outfalls would offset the loss of overland flow to the extent practicable as required by 40 CFR 436.180.

Large areas that are to be mined (mine blocks) are surrounded by ditch and berm systems before active mining operations and the ditches support surface water management for the active mine areas until those lands are reclaimed and subsequently re-connected to the watershed by removing the ditch and berm systems (also referred to as being "released" from the regulated areas). Each mine plan shows how the active mining would proceed by mine block during discrete periods of time.

The sequencing of ditch and berm installation around mine blocks, and subsequent reclamation and release schedules, define the timing and duration of removal of the particular mine block areas from contribution to downstream runoff except through NPDES outfalls and seepage from the surrounding ditch and berm systems. The acreage included in a mine's "capture area" varies over time, with the theoretical capture area curve following a somewhat parabolic shape over the course of a given mine's life cycle (these curves are presented in Chapter 4 and in Appendix G). The amount of an active mine's total footprint that is removed from contribution to downstream water deliveries is less than the total footprint, and the relative influence on downstream water deliveries is variable rather than static. Understanding the effects of a given mine on downstream water deliveries thus requires assessment of this dynamic relationship over the full life cycle of the mine. Details on the analysis of capture area relationships for each of the alternatives with schedules are provided in Appendix G.

The capture curves for each of the Applicants' Preferred Alternatives and reasonably foreseeable alternatives were developed as an independent analysis of possible mine acres directly impacted over the life of the mine. The capture area for a given mine represents the portion of the mine which retains its stormwater within the recirculation system for the period of time required to prepare the land for mining, mine the land, fill the mine pits with overburden and sand tailings, reclaim the land, and then monitor water quality until there is adequate documentation allowing mine block release from within the industrial operations' boundaries. The following assumptions based on typical current mining practices were applied in determining the capture areas for each of the four Applicants' Preferred Alternatives as a function of time during the individual mine's life cycle:

- Land clearing is initiated 1 year prior to mining.
- The ditch and berm system is constructed prior to land clearing.
- Areas to be isolated by the ditch and berm system and how the blocks would be mined were defined in the mine plan, based on current practices and typical dragline production rates (except for Wingate East Mine, which uses a hydraulic dredge).
- The active mining operation includes the filling of the mine cuts with sand tailings.
- The reclamation parcel is re-connected to the watershed 1 year after completion of reclamation (total of 3 years).
- CSAs require a minimum of 5 years for consolidation and 3 years for reclamation with the overall average being 10 years from last filling.
- The mine plan and the reclamation plan submitted with the applications were used to determine the years of capture.

The capture curves developed in this manner included the mined and disturbed lands within the mine through reclamation. For each of the four Applicants' Preferred Alternatives, the capture areas developed in this manner are conservative – that is, the area exceeded the maximum acres captured at any one time over the life of the mine as presented in the Applicants' mine plan data submitted in the applications. This independent estimate was applied in the AEIS process to bound potential changes to the schedule that may cause larger area impacts in the future. The capture areas are used to calculate the effect to the stormwater on the mines and associated stream flow in each subwatershed by defining approximate acres and years that the mines would impact watersheds during mining and reclamation activities. A similar analysis was used for the two reasonably foreseeable mines (Pine Level/Keys and Pioneer Tracts) to develop conceptual mining schedules and corresponding capture curves. The analysis of each alternative in Chapter 4 provides the capture curves and any additional assumptions applied for each alternative analyzed with this method.

The ability of a given mine to capture stormwater may be constrained by the available storage capacity in the recirculation system at the onset of rainfall events. This creates a very dynamic system and is largely dependent on the rainfall as well as the mine schedule. For the runoff calculations for each of the Applicants' Preferred Alternatives and the Offsite Alternatives, the AEIS impacts analysis approached the assessment conservatively. The water balance data included in the Water Use Permit (WUP) applications for active mines indicated a maximum 40 percent capture of runoff at existing Mosaic mines, but the data also indicated that during dry years nearly all of the runoff could be retained. To be conservatively high in the reduction of offsite runoff from an active mine area, a runoff capture of 50 percent was assumed to be a reasonably high average surface water reduction. To be even more conservative in times of drought and to form a maximum bounding scenario, it was further assumed that all of the runoff would be captured at times. For this case, the capture area analyses applied in the AEIS ignore the fact that at times some of the water captured in the active mine areas is still delivered downstream, at least through seepage from the ditch and berm system.

The ditch and berm system collects rainfall and reuses it inside the active mines, as described above. One purpose of this system is to provide the stormwater as an alternative water supply for settling ponds in the CSAs. The water stored onsite is subject to evaporation from open water or evapotranspiration (ET) from the soil and cover.

The open water evaporation rate is higher than natural ET rates from uplands, and is a direct impact that may reduce some runoff volume. Similarly, the ET is lower for bare soil, which is another direct impact that may increase some runoff volume. To estimate the relative amount of water available to storage in a year, an annual water balance was conducted to predict the Excess P on the active mine site as follows:

Excess P = Annual P – ET – Net Recharge into Surficial Aquifer – Groundwater Discharge

The Net Recharge into Surficial Aquifer and Groundwater Discharge values were obtained from the regional groundwater model developed by the Southwest Florida Water Management District (SWFWMD) (Chapter 3). The rainfall varied by watershed and ET was assigned to the acreage at each mine site that was a CSA, open mine, or reclaimed conditions. Capture rates were applied to the Excess P to determine the direct impact of stormwater reuse for each alternative. This rate was computed for each year and applied over the Applicants' Preferred Alternatives and reasonably foreseeable alternatives schedules. The values applied for ET and the range of Excess P estimated are discussed in Appendix G. This alternative computation indicated that the runoff coefficient approach provided comparable results for the active mines.

The runoff coefficient values are defined as a function of soils and land use. The surface water delivery can be described as the direct stormwater runoff during and immediately after a rainfall event plus the rainfall that is infiltrated and seeps out to the streams later. Different authors use varying terms to describe the components of the water balance in the near-surface environment. For natural systems on sloped land, there is typically a significant volume of rainfall that infiltrates but re-surfaces at lower elevations, delayed but relatively soon after a storm (from hours to days depending on the slope and geology). While not necessarily computed as direct runoff, this delayed flow is part of the record of surface water delivery as monitored at downstream USGS gages. By using observed gage runoff data to calibrate and adjust the coefficients, the coefficients inherently include all components of the surface water delivery from a watershed. Similarly, these coefficients also implicitly include past and present flow impacts from mining because these factors are reflected in the observed data used during calibration.

The surficial aquifer is the region of most interest concerning direct soil impacts because it is dramatically altered during the mining process. The surface water runoff would be affected by the nature of the top layer of soil (A horizon) and the position of the groundwater table during the year. The amount of rainfall infiltrated is reduced during high water table conditions and stored groundwater could discharge more readily when the water table is closer to the surface. Florida rules require that the restoration of the mines meet their reclamation plan objectives, but primarily with respect to the vegetation goals. The landscape is topographically restored to contours similar to pre-mining conditions, and the soils must be returned in a manner to support their use (uplands, forested wetlands, emergent wetlands, etc.). Once the reclaimed mine is released, the outfalls are removed and there is no practical way to monitor flows. Therefore, it is presumed that the long-term runoff is similar to pre-mining conditions on an area-weighted basis. Appendix G provides an overview of an assessment of the change between pre- and post-mining runoff potential. Based on available data, the net water balances between the pre- and post-mining conditions for each alternative are considered to be similar and the differences small. The runoff coefficient method was considered adequate to apply to the reclaimed mine lands.

Often the local zoning requirements or county-level plans for future land uses influence the post-mining land use (agricultural, water features, etc.); however, on a large-scale average, most of these lands would be used for agricultural purposes after mining. Following typical practices in the region, for the AEIS assessment it was assumed that 46 percent of the mined land is reclaimed to pasture, 42 percent to row crop, 5 percent to forested wetlands, and 7 percent to non-forested wetlands. This change was applied to both the existing mined land after scheduled reclamation and the alternatives analyzed quantitatively.

2.3 Surface Water Assessment Results Format

Surface water delivery for the No Action Alternative was computed for each subwatershed where the Applicants' Preferred Alternatives and the two reasonably foreseeable offsite alternative mine sites are located, with projected land use changes that included the reclaimed existing mines. This involved calculating area-weighted average runoff coefficients for each subwatershed included in the analysis for 2020, 2030, 2040, 2050, and 2060.

For each future year (the 5 cases at 10-year intervals), a spreadsheet-based computation was conducted by applying precipitation to the area-weighted runoff coefficients derived from the soil/land use polygons within the subwatershed.

For each Applicants' Preferred Alternative and the reasonably foreseeable alternatives (six alternatives total), the mine capture area curves were applied for each time period on each subwatershed to remove that amount of the mine's area from contributing flow to downstream stream or river reaches. A revised area-weighted runoff coefficient for the remaining subwatershed (i.e., without the alternative's land area) was computed to evaluate the change to the coefficient applied for that time period's runoff calculation. For the 50 percent capture scenario, runoff estimated from half of the captured mine area was added back to the subwatershed flow. Each Applicants' Preferred Alternative (Ona Mine, Desoto Mine, Wingate East Mine, and South Pasture Mine Extension) and each of the two reasonably foreseeable alternatives (Pine Level/Keys and Pioneer Tracts) was analyzed individually in Chapter 4, including the two alternatives that were qualitatively discussed (Sites A-2 and W-2). The combined effects of multiple mines operating with overlapping periods of activity were evaluated in Chapter 4.

3.0 Surface Water Quality Evaluation Methods

During and following mining, water quality parameters in mine discharges are regularly monitored and reported to the FDEP and in-stream biological conditions are also monitored through various programs (Chapter 3). Near-surface water table levels are also monitored during mining and regularly reported to SWFWMD and FDEP. The water quality assessment presented in Chapter 4 was based on recent data for current mining practices, since the Applicants' Preferred Alternatives would use similar practices.

The primary change to the water quality analysis methodology from the Draft to the Final AEIS was to add plots of the data (in Appendix D) to better illustrate the range of the data. A statistical analysis of upstream, downstream, and outfall water quality as described below was added for the Final AEIS. Additional definitions, assumptions, and explanation were added in Chapter 4 and Appendix D to address public comments and to add clarification.

Evaluation of the potential effects of the Applicants' Preferred Alternatives on surface water quality focused on discharges from NPDES-authorized mine outfalls to surface waters. Discharge monitoring results from eight NPDES outfalls at five mines were used to project the environmental consequences of all of the Applicants' Preferred Alternatives and the Offsite Alternatives on surface water quality. The monitoring data were from the following three mines that were actively involved in rock production, beneficiation, and reclamation, and two that had active reclamation projects ongoing but no rock production or beneficiation activities:

- Active Mines: Four Corners (two outfalls), Wingate Creek (two outfalls), and South Pasture (two outfalls)
- Inactive Mines: Fort Green (one outfall) and Kingsford (one outfall)

All outfall monitoring programs except the South Pasture outfalls also included background (upstream or reference locations) and downstream stations specified in the NPDES permits. Surface water quality characteristics and potential impacts were evaluated using tabular and graphic presentations of descriptive statistics for the outfall, upstream and downstream stations, statistical comparisons of paired data for outfalls and corresponding upstream and downstream stations, and summaries of the frequency of exceedances of applicable criteria where available. Detailed discussions of the methods and results of the analyses are included in Appendix D and selected portions are included in Chapters 3 and 4. Appendix D and Chapters 3 and 4 also provide additional information in response to public comments requesting more detail on numeric nutrient criteria (NNC). The results of sampling for total phosphorus, total nitrogen, and chlorophyll *a* are summarized for several mine outfalls, plus upstream and downstream locations, from 2001 through 2011. It is important to note that these data are provided for informational purposes only. The sampling procedures used to produce the data, and the sampling procedures that may be required to determine NNC compliance, may differ.

4.0 Groundwater Resource Evaluation Methods

A groundwater flow model was developed to support AEIS evaluations of the potential water level changes resulting from the No Action alternative and the Applicants' Preferred Alternatives. The model simulates the effects of pumping the Floridan aquifer on groundwater levels in the surficial aquifer system (SAS), intermediate aquifer system (IAS), and upper Floridan aquifer (UFA). Modeling was not done for Pine Level/Keys or Pioneer Tracts because there are no specific water supply plans from the Applicants. Assumptions were made that those mines would use existing wellfields, thereby extending the withdrawals over a longer timeframe but not changing the quantity. Alternatives A-2 and W-2 were not modeled because no information is available on the quantity, timeframe, or water supply plans. The model was based on the SWFWMD District-Wide Regulatory Model Version 2.1 (DWRM2.1), which is a MODFLOW model (Harbaugh et al., 2000) used by SWFWMD to conduct groundwater resource evaluations and specifically support its water supply permitting and planning decisions. Additional information on the DWRM2.1 model, including its development and calibration, can be found in its documentation (ESI, 2007). A more detailed description of model development and the simulations conducted supporting this AEIS is presented in Appendix F.

For a groundwater resource evaluation, the potential environmental consequences from phosphate mining must examine potential impacts to the surficial, intermediate, and Floridan aquifers. Chapter 3 provides a discussion of aquifer systems. Use of the Floridan aquifer system (FAS) as a water supply by phosphate mines was identified as a particular issue of concern during the scoping process. The mining industry's groundwater withdrawals cause drawdown of the FAS, which could result in impacts in the form of increased saltwater intrusion, reduced groundwater contributions to regional river flows, and associated net impacts on regional water supply interests of potable water suppliers or others reliant on the Floridan aquifer for water supply purposes. These effects could be direct or indirect effects associated with a single mine, or cumulative effects associated with multiple mines, or multiple mines plus other water users. The surficial and intermediate aquifers were also evaluated using the groundwater model to determine mining operation impacts to the surficial aquifer and Floridan aquifer pumping impacts to the Intermediate aquifer.

Of the alternatives developed in Chapter 2, information on the proposed durations and schedules of mining and associated use of Floridan aquifer wells for water supply augmentation was available from the Applicants to support analysis of the existing operating mines (No Action Alternative) and the four Applicants' Preferred Alternatives (Desoto Mine, Ona Mine, Wingate East Mine, and South Pasture Mine Extension), which were designated Alternatives 2, 3, 4, and 5, respectively. As described in Chapter 3, the Wingate East Mine and the South Pasture Mine Extension are mine extensions, where new mine water supply wells and/or new FAS allocations would not be needed. The extensions would, however, extend the planned period of operations of the parent mine. The Ona Mine would require new water supply wells to be installed in accordance with the already permitted allocation from the FAS. The Desoto Mine is proposed to rely on water supply drawn from an existing phosphate mine well system, with pipeline conveyance to deliver the water to the new mine location.

These water supply strategies would be among those that could be considered by any reasonably foreseeable mine projects. Analysis of the potential effects of the Preferred Alternatives mine projects on the regional UFA, as well as the SAS and IAS, illustrates the order of magnitude effects that can be anticipated for reasonably foreseeable mine projects of similar spatial and temporal scale.

4.1 DWRM2.1 Analytical Overview

The No Action Alternative is described in Chapter 2 and Chapter 4. Under this alternative, existing mines would continue to operate as approved until the end of their rock production, but new permits for the Applicants' Preferred Alternatives would be denied, or modified to eliminate all discharges of dredged or fill material into Waters of the U.S.

Table 1 summarizes the projected periods of mine operations for the existing phosphate mines within the CFPD; this summary represents the No Action Alternative. As indicated, under the 2010 baseline set of operational conditions, the mines in rock production operation consisted of Mosaic's Four Corners/Lonesome, Hookers Prairie, South Fort Meade, and Wingate Creek Mines, and CF Industries' South Pasture Mine. Mosaic's Hopewell facility also maintained an FAS water supply allocation to support ongoing reclamation activities.

TABLE 1
Projected Floridan Aquifer Groundwater Withdrawal Rates (mad) - Alternative 1, No New Mines
Central Florida Phosphate District, FL

Year	Four Corners	Hookers Prairie	Hopewell	Ona	Desoto	South Fort Meade	Wingate	South Pasture	Total
2010	15.6	4.2	0.5	0	0	11.3	5.8	6.39	43.79
2011	15.6	4.2	0.5	0	0	11.3	5.8	6.39	43.79
2012	15.6	4.2	0.5	0	0	11.3	5.8	6.39	43.79
2013	15.6	4.2	0.5	0	0	11.3	5.8	6.39	43.79
2014	15.6	4.2	0.5	0	0	11.3	5.8	6.39	43.79
2015	15.6	0	0.5	0	0	11.3	5.8	6.39	39.59
2016	15.6	0	0	0	0	11.3	5.8	6.39	39.09
2017	15.6	0	0	0	0	11.3	5.8	6.39	39.09
2018	15.6	0	0	0	0	11.3	5.8	6.39	39.09
2019	15.6	0	0	0	0	11.3	5.8	6.39	39.09
2020	0	0	0	0	0	11.3		6.39	17.69
2021	0	0	0	0	0	0	0	6.39	6.39
2022	0	0	0	0	0	0	0	6.39	6.39
2023	0	0	0	0	0	0	0	6.39	6.39
2024	0	0	0	0	0	0	0	6.39	6.39
2025	0	0	0	0	0	0	0	6.39	6.39

Note:
Yellow-shaded rows indicate years for which steady-state model simulations were conducted and output was generated.

The year 2010 was used as the "baseline year" representing present conditions because at the time of the start of AEIS preparation (February 2011), 2010 was the latest year for which FAS withdrawal information was compiled by the SWFWMD. Conditions of the groundwater resources evaluated using the 2010 withdrawals represented the cumulative effects of all prior phosphate mining, agricultural activities, and urban, industrial, commercial, and recreational development through 2010.

The use of 2010 as the baseline year for AEIS impact evaluations pertaining to SAS, IAS, and UFA water levels was the approach adopted to provide that "…the current aggregate effects of past actions…" was used in the AEIS' cumulative effects review. Modeling of the current FAS water supply allocations to all users of the Floridan aquifer set the baseline water levels reflecting the influences of all such users, including past uses, and future changes from this baseline to reflect the cumulative impacts of the future scenarios of water supply uses by the various water supply categories. For the groundwater modeling analyses, the nominal 2010 condition actually represents the baseline FAS water supply allocations permitted by the SWFWMD through 2006 and included in the DWRM2.1 model. Since regional water use did not change significantly for 2006 to 2010, this approach was reasonable. Use of this baseline year for comparative purposes is the typical procedure applied by all of the water management districts in assessing the potential effects of any proposed change in existing FAS water supply allocations, and the approach was adopted to support the AEIS to remain as consistent as possible with how the cumulative effects of all user categories on aquifer water levels would be evaluated by the SWFWMD.

The 2010 baseline condition represents SWFWMD's current level of FAS water supply allocations to all Floridan aquifer users, inclusive of the above listed phosphate mining operations, potable water supply systems, agriculture, recreational irrigation, industrial/commercial operations, and any other permitted wellfield systems. Where those allocations have been reduced by the mining industry, or otherwise modified over time, the FAS water level recoveries are reflected by the baseline 2010 simulations against which all other scenarios modeled are compared.

As summarized in Table 1, by 2016, the Hookers Prairie allocation is reduced to a lower level solely supporting reclamation activities; the other water supply allocations remain essentially unchanged except for a slight reduction in the allocation for the South Pasture Mine. By 2025, the Four Corners/Lonesome Mine’s water supply allocation is reduced to a reclamation support level; the others remain the same. By 2030, only the South Fort Meade and South Pasture Mines are predicted to remain in rock production operation mode. By 2035, only the South Fort Meade Mine is predicted to still be in operation, supporting reclamation. The No Action set of model runs conducted to evaluate the likely changes in FAS water levels associated with this alternative consisted of model runs for these years, highlighted in yellow in Table 1. This set of model runs is based on the no new mines scenario where the four proposed new phosphate mines would not be authorized.

In contrast, Table 2 summarizes the projected operating periods of the existing phosphate mines as well as the Applicants’ Preferred Alternatives (Desoto Mine, Ona Mine, Wingate East Mine, and South Pasture Extension Mine). The Desoto and Ona Mines would be new mines with discrete predicted start and stop points in time; their indicated water supply allocations represent new FAS withdrawal allocations compared to the 2010 baseline condition. In contrast, the Wingate East Mine and South Pasture Extension Mine would merely result in increased durations of the operational periods of the Wingate Creek Mine and South Pasture Mine. The rock production operational periods for some of the Applicants’ Preferred Alternatives would extend as far as 2048 based on information provided by the Applicants. This timeframe would include reclamation activities. As stated above, on the basis of these projections, the temporal scope for this issue was determined to be 40 years. Within that timeframe, selected years for which model runs were conducted to support AEIS evaluations of the No Action Alternative (Alternative 1) plus the Desoto Mine, Ona Mine, Wingate East Mine, and South Pasture Extension Mine (Alternatives 2, 3, 4, and 5, respectively), as well as the cumulative impacts of Applicants’ Preferred Alternatives in combination, are highlighted in yellow in Table 2.

As the withdrawals by the industry change in quantity and location in the future, the water levels in the UFA would change in response to those pumping stresses. In much of the study area, the UFA water levels remain the same or increase, leading to no detrimental impact to other well owners. Where increased drawdown in the UFA occurs, other well owners may experience lower water levels during parts of the year. The model was used to estimate the number of other wells that may experience lower water levels by using the well location file in the model and extracting out the water level change under steady-state conditions. A summary table of the number of wells with more than 1 foot of drawdown resulting from mining withdrawals is presented in Chapter 4 and in Appendix F.

The impact of mining on changes in groundwater discharge to rivers was evaluated using the DWRM2.1 model, the surface water evaluations in Appendix G, and data from the 2010 SWFWMD Water Supply Plan (SWFWMD, 2010a. The Water Supply Plan summarized the surface water available to help meet public supply demand for each watershed. The evaluation of the changes in available surface water was performed using permitted withdrawals from surface water users and the estimated available quantities in each river provided in the 2010 Water Supply Plan (SWFWMD, 2010a). Table 3 presents a summary of surface water availability to meet public supply demand. Using the results of the surface water analysis described in Appendix G and the changes in flow from River cells in the DWRM2.1 model for Alternatives 2, 3, 4, and 5, an estimate of the combined changes in river flow resulting from mining was prepared. The results indicated a net increase in river flow as a result of land use changes in the region and an increased groundwater discharge to the rivers resulting from mining.

TABLE 2
Projected Floridan Aquifer Groundwater Withdrawal Rates, mgd - Alternatives 1, 2, 3, 4, and 5 using Drought Year and Flexible Withdrawals
Central Florida Phosphate District, Florida

Year	Four Corners	Hookers Prairie	Hopewell	Ona	Desoto	South Fort Meade	Wingate/ Wingate East	South Pasture	Total
2010 [a]	15.6	4.2	0.5	0	0	11.3	5.8	6.39	43.79
2011	15.6	4.2	0.5	0	0	11.3	5.8	6.39	43.79
2012	15.6	4.2	0.5	0	0	11.3	5.8	6.39	43.79
2013	15.6	4.2	0.5	0	0	11.3	5.8	6.39	43.79
2014	15.6	4.2	0.5	0	0	11.3	5.8	6.39	43.79
2015A	15.6	0	0.5	0	0	11.3	5.8	6.39	39.59
2015B	20	0	0.5	0	0	11.2	5.7	6.39	43.79
2015C	15.7	0	0.5	0	0	15.4	5.8	6.39	43.79
2016	15.6	0	0	0	0	11.3	5.8	6.39	39.09
2017	15.6	0	0	0	0	11.3	5.8	6.39	39.09
2018	15.6	0	0	0	0	11.3	5.8	6.39	39.09
2019A	15.6	0	0	0	0	11.3	5.8	6.39	39.09
2019B	20	0	0	0	0	11.6	5.8	6.39	43.79
2019C	16.2	0	0	0	0	15.4	5.8	6.39	43.79
2020A	0	0	0	11.9	0	11.3	5.8	6.39	35.39
2020B	0	0	0	15.0	0	15.4	5.8	6.39	42.59
2021	0	0	0	11.9	10.7	0	5.8	6.39	34.79
2022	0	0	0	11.9	10.7	0	5.8	6.39	34.79
2023	0	0	0	11.9	10.7	0	5.8	6.39	34.79
2024	0	0	0	11.9	10.7	0	5.8	6.39	34.79
2025A	0	0	0	11.9	10.7	0	5.8	6.39	34.79
2025B [a]	0	0	0	15	10.7	0	5.8	6.39	37.89
2026	0	0	0	11.9	10.7	0	5.8	6.39	34.79
2027	0	0	0	11.9	10.7	0	5.8	6.39	34.79
2028	0	0	0	11.9	10.7	0	5.8	6.39	34.79
2029	0	0	0	11.9	10.7	0	5.8	6.39	34.79
2030	0	0	0	11.9	10.7	0	5.8	6.39	34.79
2031	0	0	0	11.9	10.7	0	5.8	6.39	34.79
2032	0	0	0	11.9	10.7	0	5.8	6.39	34.79
2033	0	0	0	11.9	10.7	0	5.8	6.39	34.79

TABLE 2
Projected Floridan Aquifer Groundwater Withdrawal Rates, mgd - Alternatives 1, 2, 3, 4, and 5 using Drought Year and Flexible Withdrawals
Central Florida Phosphate District, Florida

Year	Four Corners	Hookers Prairie	Hopewell	Ona	Desoto	South Fort Meade	Wingate/ Wingate East	South Pasture	Total
2034	0	0	0	11.9	10.7	0	5.8	6.39	34.79
2035	0	0	0	11.9	10.7	0	5.8	6.39	34.79
2036A	0	0	0	11.9	0	0	5.8	6.39	24.09
2036B	0	0	0	15	0	0	5.8	6.39	27.19
2037	0	0	0	11.9		0	5.8	6.39	24.09
2038	0	0	0	11.9		0	5.8		17.70
2039	0	0	0	11.9		0	5.8		17.70
2040	0	0	0	11.9		0	5.8		17.70
2041	0	0	0	11.9		0	5.8		17.70
2042	0	0	0	11.9		0	5.8		17.70
2043	0	0	0	11.9		0	5.8		17.70
2044	0	0	0	11.9		0	5.8		17.70
2045	0	0	0	11.9		0	5.8		17.70
2046	0	0	0	11.9		0	5.8		17.70
2047A	0	0	0	11.9		0	0		11.90
2047B	0	0	0	15		0	0		15.00
2048	0	0	0	11.9		0	0		11.90
2049	0	0	0	0		0	0		0.00
2050	0	0	0	0		0	0		0.00
Transient Model Peaking Factor	1.74	1.64	1.25	1.88	1.88	1.62	1.25	1.17	

Note:
[a]Transient models also developed for these scenarios.
Minor quantities may be used for reclamation activities as facilities close down. The South Pasture Mine withdrawals in years 2036 and 2037 are for reclamation and infill parcels.
Yellow-shaded rows indicate years for which steady-state model simulations were conducted and output was generated.

TABLE 3
Surface Water Available to Meet Public Supply Demand
Central Florida Phosphate District, Florida

	SWFWMD Water Supply Plan					Watershed Wide Mining Operation Impacts from 2009 to 2050		
Watershed	**Adjusted Annual Average Flow[a] mgd**	**Permitted Average Withdrawal[a] mgd**	**2003 to 2007 Withdrawal[a] mgd**	**2003 to 2007 Unused Permitted Withdrawal[a] mgd**	**Unpermitted Potentially Available Withdrawal [a] mgd**	**Change in Surface Water Runoff[b] mgd**	**Change in Streamflow Contribution from Groundwater[c] mad**	**Total Change in Streamflow Contribution[d] mgd**
Peace River	813.0	32.8	14.9	17.9	80.4	62.69	14.52	77.21
Hillsborough River	255.0	113	91.6	21.4	TBD	NC	2.78	NC
Alafia River	261.0	23.6	15.7	7.9	18.5	NC	3.02	NC
Manatee River	117.0	35	30	5	2.2	NC	0.25	NC
Little Manatee River	98.6	8.7	3.7	5	0.2	NC	0.36	NC
Myakka River	163.5	0	0	0	41.7	18.10	1.15	19.25
Withlacoochee River	1002.0	0.5	0.01	0.49	93.2	NC	0.96	NC
Total	**2710.1**	**213.6**	**155.91**	**57.69**	**236.2**	**80.8**	**23.0**	**96.5**

Notes:
[a] Values are from SWFWMD 2010 Water Supply Plan
[b] Values are from Surface Water Analysis, Appendix G (Only the Peace and Myakka River Watersheds were assessed for future changes to flow resulting from land use change in the AEIS)
[c] Values are from Groundwater Modeling River Cells for Alternatives 1, 2, 3, 4, and 5
[d] Sum of Change in Surface Water Runoff and Change in Streamflow Contribution from Groundwater
NC = Not Calculated

Seasonal variability in withdrawal rates typically results in regional lowering of aquifer levels during the spring dry season and recovery of water levels in the winter. This evaluation was performed by first compiling regional withdrawals for all water use types for 7 years (from 1996 to 2002) using information from SWFWMD. This compilation was used to determine the monthly multipliers applicable to each water use type (i.e., public supply, agriculture, industrial, etc.). Those multipliers were used in the future model simulations to ultimately develop the seasonal water level changes tables and graphs. Seasonal recharge values were obtained from the DWRM2.1 transient model calibration files and were applied to the future model simulations in the appropriate month of the simulations. Three transient models were set up to evaluate seasonal variations within the IAS Zone 1, Zone 2, and the UFA aquifer layers using 13 stress periods, or time periods. Variations in the SAS were not evaluated because the SAS was not calibrated to transient conditions. Also, the River and Drain cell elevations were not modified from steady state. As a result, the DWRM2.1 cannot be used to reliably simulate the SAS under transient conditions. Therefore, seasonal variations in SAS water levels were not simulated. Seasonal variations can only be simulated reliably using a local-scale model that incorporates the site-specific aquifer, surface water, topographic, and drainage detail that was unavailable for this study.

The base year 2010 was modeled along with two models for the year 2025: one representing the change in withdrawal from all users and one for the change in withdrawal by mining only. The mining withdrawal is the same as in Alternatives 2, 3, 4, and 5: 2025B with the Ona Mine at its flexible permit withdrawal rate. The transient model peaking factor was applied to the Stress Period 5, which represents the month of April (Ona: 1.88, Desoto: 1.88, Wingate East: 1.25, and South Pasture Extension: 1.17). An intermediate peaking factor was applied to the month preceding and following April in order to represent the dry season. The rest of the months were adjusted downward, so that the average withdrawal for the year is the same as the drought year average annual. The other users' well withdrawals were adjusted according to well type using the multipliers, which were averaged using data from the DWRM2.1 transient calibration as discussed above.

4.2 Key Working Assumptions for the Groundwater Modeling

Tables 1 and 2 reflect the drought year permitted annual FAS allocations and the currently anticipated FAS use periods for the indicated mines based on the existing WUP-defined allocations currently authorized by the SWFWMD (Mosaic WUP No. 20011400.025, expiration 2032; CF Industries WUP No. 20003669.010, expiration 2017). For these AEIS evaluations, a key assumption applied was that the Applicants' currently authorized annual average FAS allocations would remain the same out through 2040. Additionally, it is notable that these groundwater model simulations are conservative estimates of the potential effects of these new mine projects on aquifer water levels since the simulations were run using drought year withdrawals, which are significantly higher than permitted annual average and more so when actual withdrawals are considered.

The water supply allocations used in the modeling are drought year withdrawals that could be conducted to support matrix extraction and transport to the beneficiation plants, and for subsequent clay and sand tailings conveyance. In reality, actual pumping rates vary depending on precipitation. Phosphate mines in the past decade have used substantially less than their drought year or annual average water supply allocations authorized under WUPs because of modified water management practices, including a greater reliance on surface waters contained within their recirculation systems.

As addressed in Chapter 3, some mines have not had to pump their FAS wells for years, because adequate water supply was available as a result of rainfall accumulations and industry efforts focused on water conservation and reuse. Conversely, under drought conditions, increased pumping rates and longer duration FAS withdrawals can be needed. For this AEIS evaluation, however, the analysis focused on long-term average conditions and the conservative approach adopted was to conduct the model simulations using the annual average allocation rates.

As noted above, DWRM2.1 is the primary analytical tool used by the SWFWMD in evaluating proposed water supply allocations from the FAS under its water use regulatory program. Mosaic recently completed consolidation of its various mine-specific individual WUPs into an Integrated Water Use Permit (IWUP). Detailed groundwater modeling was conducted in support of the IWUP application (Progressive Water Resources [PWR], 2011) using a model based on DWRM2.1. The groundwater modeling conducted in support of this AEIS is different than the modeling recently conducted by Mosaic to support the IWUP application in several ways. For example, in the application, standard SWFWMD water use permitting simulations are run without making changes to any of the groundwater withdrawals of other water users included in the model. In contrast, for analysis of potential effects of projects addressed under this AEIS, the analyses included consideration of future changes in such allocations for other users.

A second difference between the AEIS modeling and standard groundwater modeling supporting Mosaic's IWUP application reviews by SWFWMD is that the water use permitting simulations only addressed Mosaic's projected FAS water uses to 2030, which corresponded to the duration covered by the IWUP. For the AEIS, simulations had to address various mine operations through approximately 2050, and also had to account for the proposed changes to the CF Industries duration of use of the South Pasture Mine/South Pasture Mine Extension wells.

In the Southern Water Use Caution Area (SWUCA) recovery strategy, SWFWMD recognizes that "annual withdrawals from the Floridan aquifer need to be reduced by 50 mgd (from 650 to 600 mgd) to ensure that the saltwater intrusion minimum aquifer level is met." However, "if withdrawals were optimally distributed (i.e., declines in the most impacted areas and increases in the least impacted areas) a reduction of significantly less than 50 mgd would be required."

Nonetheless, for the DWRM2 model, a 50-mgd reduction of agricultural groundwater use was used, with all other users capped at their current levels. It should be noted that in the same report, SWFWMD recognizes that reductions in phosphate industry groundwater quantities have played an important role in SWUCA recovery, stating, "Average daily use of groundwater associated with mining and processing of phosphate ore in the SWUCA has declined from over 300 mgd in the mid-1970s to less than 75 mgd in recent years…" (SWFWMD, 2006b). Allocations for groundwater withdrawals for other users would be maintained at their current levels. Thus, for the AEIS modeling evaluations, projected agricultural use reductions of 50 mgd were accounted for, but all other users' allocations were maintained at the 2006 rates included in the DWRM2.1 model. It was assumed that withdrawal rates in the base year conditions of 2010 were the same as in 2006, since there was very little growth in demand between 2006 and 2010.

For the modeled scenarios, a linear rate of decrease (-2.5 mgd/yr) in agricultural withdrawal allocations was assumed to occur between 2005 and 2025. This reduction was simulated as follows:

- 2010 12.5 mgd reduction
- 2020 37.5 mgd reduction
- 2030–2060 50 mgd reduction

The reductions above were applied proportionally to each agricultural well in the SWUCA, based on the well's simulated withdrawals. These types of adjustments to account for changed allocations of other users in the future are not applied during water use permitting-based modeling analyses. While it is recognized that agricultural use reductions would not be uniform throughout the region, there is no reasonable methodology available to predict the future pattern of change so the uniform assumption is the best available method for incorporating the changes in agricultural use in the model.

These differences are noted to clarify that the AEIS modeling results are not comparable to those generated by PWR (2011) because of the different analytical objectives, the modeling assumptions applied, and the different modeling conditions included in the respective analyses.

4.3 Groundwater Model Results Presentation Formats

Each model run consisted of a steady-state simulation for which drawdown was calculated and compared relative to 2010 conditions. While water demand projections were developed for every mine for the years 2010 through 2050, model runs were only conducted for years in which there were significant changes in withdrawals relative to adjacent years (for example, a new mine might begin operating, or a mine might have shut down). Many years have the same pumpage as the preceding and following years; thus no additional information would be gained by running annual simulations because the results would be identical.

The SWFWMD has established a Saltwater Intrusion Minimum Aquifer Level (SWIMAL) for the SWUCA (SWFWMD, 2002b). This level is the "*minimum aquifer level necessary to prevent significant harm caused by saltwater* *intrusion in the UFA in the SWUCA*." The SWIMAL is calculated each year based on the 10-year average water level in 10 specific SWFWMD monitoring wells in the SWUCA. Each well is assigned a weight based on a GIS analysis performed by the SWFWMD. The individual well averages and weights are used to develop a single SWIMAL value for the aquifer.

Because this study evaluated simulated drawdown rather than aquifer levels, the simulated drawdown at each observation well was multiplied by the adjusted SWIMAL weight to obtain a weighted drawdown for the well. Individual weighted drawdowns were summed to quantify the simulated change in the SWIMAL for each model run.

The simulated water level change is presented in 85 Regional Observation Monitoring Well Program (ROMP) monitor wells that are within the model domain: 16 wells in Layer 1, 17 wells in Layer 2, 18 wells in Layer 3, and 34 wells in Layer 4. Unlike the SWIMAL, the water level change at each of these wells is assessed separately. The monitor wells were selected from a database of 1,304 wells in the SWFWMD. The 85 wells were selected because they comprised the network of wells used to calculate the SWIMAL, were within the SWUCA, were not located close to one another, represented a good distribution across the study area, and are completed in each of the aquifer zones of interest (i.e. SAS, IAS, and UFA).

For the No Action Alternative (Alternative 1) and the Applicants' Preferred Alternatives (Alternatives 2, 3, 4, and 5) and for each simulation year analyzed, two predictions were run. For all simulations, water level changes were determined in the SAS, IAS Zone 1, IAS Zone 2, and UFA ROMP wells. The No Action Alternative was simulated with the applicable mine water supply allocations for drought year withdrawals with all other groundwater users unchanged at 2010 rates. Agricultural uses remained unchanged for these simulations. A second set of simulations was run for the same conditions except with the 50 mgd agricultural reduction included. The offsite alternatives were not included in the modeling because no water supply plans are available.

For the Applicants' Preferred Alternatives, the water supply allocations from Alternative 1 were added to the projected allocations in Alternatives 2, 3, 4, and 5. These simulations are the cumulative impacts simulations. These simulations were run the same as above, with one set of simulations including the applicable mine water supply allocations for drought year withdrawals and all other groundwater users unchanged at 2010 rates. Agricultural uses remained unchanged for these simulations. A second set of simulations was run for the same conditions except with the 50 mgd agricultural reduction included. The indicated combinations of mine operations over the study period provided information on the effects of all mining with and without the agricultural reduction.

The comparative analysis yielded estimates of the relative magnitude of the phosphate mining effects on the SAS, IAS, and UFA water levels and the relative spatial extent of drawdown or recovery effects out to a 0.5-foot contour (either drawdown [- values] or recovery [+ values]). These measures also were used to calculate an overall relative influence of phosphate mining withdrawals for the indicated simulation years calculated for the CFPD, and comparative metrics were also calculated for the influence of all users combined. Lastly, the results allowed calculation of the effects of the various mine combinations in relation to conditions at specific regional monitoring wells (ROMP wells) for which SWFWMD has set Minimum Flows and Levels (MFL) targets. The ROMP well groupings are addressed further in the discussion of modeling results presented in Chapter 4 and in Appendix F.

4.4 Qualitative Assessment of Groundwater Effects

As explained in the introduction to this section, modeling was not done for Pine Level/Keys or Pioneer Tracts because there are no specific water supply plans from the Applicants. Assumptions were made that those mines would use existing wellfields, thereby extending the withdrawals over a longer timeframe but not changing the quantity. Alternatives A-2 and W-2 were not modeled because no information is available on the quantity, timeframe, or water supply plans. These alternatives' effects on groundwater were considered qualitatively, by extrapolating the modeled results of other alternatives or existing mines' effects. Pine Level/Keys Tract was compared to Desoto Mine, Pioneer Mine was compared to Ona, Site A-2 was compared to the existing South Fort Meade Mine, and Site W-2 was compared to the existing Wingate Creek Mine.

5.0 Ecological Resource Impact Analysis Methods

Ecological resources could be impacted by various aspects of phosphate mining operations, such as land clearing in advance of mining, mining activities, and construction of the infrastructure supporting mining such as access roads, pipeline corridors, and CSAs. Ecological effects may be direct such as the clearing of wetlands within areas to be mined, or indirect, such as the dewatering of wetlands adjacent to mining areas. For the Draft AEIS, the ecological impact analyses for all alternatives evaluated, including the Applicants' Preferred Alternatives, were based largely on GIS-based data/tools. Public comments received on the Draft AEIS recommended that the ecological impact analyses for the Applicants' Preferred Alternatives be based primarily on field-collected data included in the Applicants' federal Section 404 permit applications to allow for more accurate representation of the ecological resources that exist on the Applicants' Preferred Alternatives. In response to these recommendations, the ecological impact analyses conducted for the Applicants' Preferred Alternatives for the Final AEIS were based primarily on information included in the Applicants' Section 404 permit applications. The information obtained from the Section 404 permit applications for the ecological impact analyses included field data collected by the Applicants on aquatic biological communities, wetlands/waters, wildlife habitats, and listed species, as well as the Applicants' proposed impact avoidance/minimization measures and compensatory mitigation.

Site-specific field data on ecological resources for the offsite alternatives were unavailable at the time of preparation of this AEIS. In lieu of collecting field data for each offsite alternative, the following GIS-based data/tools were used to support the analysis of potential impacts of each offsite alternative on ecological resources:

- 2009 SWFWMD Florida Land Use, Cover, and Forms Classification System (FLUCCS) data (SWFWMD, 2009a)
- USGS National Hydrography Dataset (NHD) data (USGS, 2013b)
- Critical Lands and Waters Identification Project (CLIP) tool (Florida Natural Areas Inventory [FNAI] et al., 2011)

FLUCCS is the primary system used to classify land use and cover in Florida (see Chapter 3). For this AEIS, FLUCCS data were used to estimate the spatial coverage (in acres) and composition (types) of wetlands, non-stream surface waters, native uplands (rangelands and upland forests), and agricultural land on each offsite alternative. The comprehensive FLUCCS data for the offsite alternatives are provided in Appendix E-1.

The NHD is a USGS digital-vector dataset used for mapping and geospatial analysis of surface waters (USGS, 2013b). For this AEIS, NHD data were used to estimate the total stream length (in linear feet) on each offsite alternative. The linear feet of streams were calculated as the combined length of all NHD flowline features except for the "canal/ditch" feature. The comprehensive NHD data for the offsite alternatives are provided in Appendix E-2.

CLIP is a GIS-based tool that allows rapid assessment of the ecological quality and importance of a given parcel of land in Florida. The CLIP User Tutorial includes guidelines for use of CLIP data, including a disclaimer that CLIP data are not intended to be used for regulatory permitting decisions. For this AEIS, CLIP provides estimates of the quality of wetlands on each offsite alternative without the need to obtain permission to access the sites, do field surveys, etc. Any U.S. Army Corps of Engineers (USACE) permitting decisions related to this AEIS would be supported by additional data beyond the data available using CLIP, including site-specific, field-verified information.

The CLIP tool was developed through a collaborative effort between the FNAI, University of Florida, and Florida Fish and Wildlife Conservation Commission (FFWCC). The CLIP tool has been revised and updated with new data since its initial creation in 2006. CLIP 2.0, the 2011 update of the tool used for this AEIS, is organized into a set of core GIS data layers that are combined into five resource models: Biodiversity, Landscapes, Surface Water, Groundwater, and Marine. Depending on the model or data layers used, CLIP can provide a broad assessment of the overall ecological quality of an area, or it can provide a more focused assessment of the quality of a specific resource within an area, such as wetlands. According to the CLIP tool, areas or specific resources that are ranked as CLIP Priority 1 or 2 have the highest priority for conservation significance (FNAI et al., 2011). In lieu of Wetland Rapid Assessment Procedure (WRAP) or Uniform Mitigation Assessment Methodology (UMAM) data, which are not available for the offsite alternatives, the CLIP "Wetlands" GIS data layer, which is a component of the CLIP Surface Water model, was used to assess the quality of wetlands on each offsite alternative. The CLIP Wetlands layer has six priority levels, reported from 1 to 6. Priority 1 represents the highest conservation priority level and Priority 6 represents the lowest conservation priority level. For this AEIS, wetlands ranked as CLIP Priority 1 and 2 are considered to represent wetlands of high quality, wetlands ranked as CLIP Priority 3 and 4 are considered to represent wetlands of moderate quality, and wetlands ranked as CLIP Priority 5 and 6 are considered to represent wetlands of low quality on each offsite alternative. Accordingly, the percentages of wetlands ranked as CLIP Priority 1 and 2 (high-quality wetlands), wetlands ranked as CLIP Priority 3 and 4 (moderate-quality wetlands), and wetlands ranked as CLIP Priority 5 and 6 (low-quality wetlands) were calculated for each offsite alternative. The comprehensive CLIP Wetland data for the offsite alternatives are provided in Appendix E-3.

6.0 Economic Evaluation Methods

An independent assessment of the effects of the Applicants' Preferred Alternatives on economic activity was performed to support the evaluation of the consequences of projects proposed by the Applicants and currently under USACE review.

Information on the proposed durations and schedules of mining were available for the four Applicants' Preferred Alternatives (Desoto Mine, Ona Mine, Wingate East Mine, and South Pasture Mine Extension). In addition, conceptual mine plans were prepared for two offsite alternatives (the Pine Level/Keys Tract and Pioneer Tract). These two offsite alternatives were evaluated as alternatives to the Applicants' Preferred Alternatives, and as reasonably foreseeable alternatives as part of the cumulative impacts assessment. Insufficient information was available to prepare similar analyses for the two other offsite alternatives (A-2 and W-2). In addition, these alternatives were not considered reasonably foreseeable. The economic analyses considered the potential effects of each of the four Applicants' Preferred Alternatives for the expected life of each mine, plus the cumulative mining impacts of the four proposed mines, plus the two reasonably foreseeable offsite alternatives from the 2010 baseline condition through 2060.

The AEIS economic evaluations included evaluation of direct, indirect, and induced impacts of the Applicants' Preferred Alternatives and the two reasonably foreseeable offsite alternatives on an eight-county region consisting of five counties in the CFPD and three adjoining counties. The analyses of the individual mines consider the impacts of the four Applicants' Preferred Alternatives, and two reasonably foreseeable offsite alternatives. The cumulative areawide analyses evaluated the impact of all of the Applicants' Preferred Alternatives and reasonably foreseeable offsite alternatives being permitted, as well as the impact of multiple alternatives being approved in a single county (Hardee), and the impacts of the Wingate East Mine, Desoto Mine, and Pine Level/Keys Tract being approved on the combination of DeSoto and Manatee Counties. Direct, indirect, and induced impacts are defined as follows:

- Direct Impacts – Refers to the change in the impact of a change in "final demand" on a given business or industry. In this case it refers to the change in value of phosphate production and agricultural production resulting from the permitting of the Applicants' Preferred Alternatives and the two reasonably foreseeable offsite alternatives.
- Indirect Impacts – Indirect impacts are the employment and income generated by the purchase of goods and services from local suppliers by the directly impacted industries.
- Induced Impacts – Induced impacts result from changes in household expenditures, as employees of the directly or indirectly impacted businesses purchase goods and services in the local economy.

Direct economic effects would be anticipated predominantly on the specific counties where the proposed mines would be located. Some direct impacts may also accrue to surrounding counties. For example, this analysis associated direct employment and labor income impacts to the place of work (location of mine), not the place of residence. To the extent that employees reside in another county, it could be argued that some direct employment and labor income impacts would occur to the surrounding counties. Indirect and induced economic effects would occur on the counties where the mines would be located and to varying degrees on the surrounding counties. For this economic analysis, the area included in the evaluation encompassed each county in its entirety, not just the areas that would be mined or downstream from the proposed mines. The direct impacts on the prospective host counties (Manatee, Hardee, and DeSoto Counties) were evaluated along with the indirect and induced effects on these counties, as well as for Polk, Hillsborough, Charlotte, Sarasota, and Lee Counties. Economic impacts outside the eight-county region were not included in this analysis.

Direct impacts would result from the mining and reclamation activities and changes in agricultural activities in the Applicants' Preferred Alternatives as land currently devoted to pasture, citrus, and row crops would be converted to mining and then returned to agricultural or other uses over the study period. Other direct impacts would relate to revenues to local governments, including severance taxes and ad valorem taxes. Indirect and induced impacts would consist of secondary impacts generated by the purchase of goods and services from local suppliers by the mining and agricultural activities and by their employees. Indirect and induced impacts resulting from direct impacts were estimated using an economic modeling application called Impact Analysis for Planning (IMPLAN) (MIG Inc., 2012). Information on IMPLAN is accessible at www.implan.com/.

The purpose of these evaluations was to compare a number of different scenarios associated with their respective economic values:

- No Action Alternative
- Alternatives 2 through 7—The impact on host counties of individual alternatives, referred to as the "Mining Alternatives" (as noted previously, Alternatives 8 and 9 are not considered further in this analysis)
- Mining Contribution to Cumulative Impacts—The areawide impacts of permit approval of the individual mines plus reasonably foreseeable offsite alternatives This includes:
  - The impact of the three Hardee County mines (Ona Mine, South Pasture Mine Extension, and Pioneer Tract
  - The impact of Manatee and DeSoto County mines (Desoto Mine, Wingate East Mine, and Pine Level/Keys Tract)
  - The impact of mines in an eight-county region, resulting from the Applicants' Preferred Alternatives and the Pioneer and Pine Level/Keys Tracts

The impacts in each analysis were measured for 10-year increments over a 50-year period (2010 to 2060). The 10-year increments were used for this analysis because the timing of the mining was not considered precise enough to warrant shorter time increments. This analysis projected the average annual level of economic productivity over each 10-year period. The total impacts were the summation of the direct, indirect, and induced impacts. The net present value of the difference in output or income between the mining alternatives and the No Action Alternative was calculated to estimate the change in employment and income associated with the mining scenario being evaluated. Present value analysis is a tool for comparing alternatives with varying schedules of costs and/or revenues over time. Future costs and revenues are discounted to estimate their present worth.

6.1 Overview of Calculation Methods

Key calculation methods supporting the economic evaluations are summarized in the following paragraphs.

6.1.1 Value of Output (Total Income)

The monetary value of the direct output of the mining and agricultural activities was calculated by associating the change in land use within the mine footprint over time with an estimated land use revenue production rate. The change in land use associated with each mine over the 50-year period was forecast based on the mine plans. The number of acres of land mined in each 10-year period multiplied by the average tonnage of phosphate rock produced per acre and by the value of the phosphate rock per ton provided the value of the phosphate rock produced in each 10-year period. Similarly, the average annual inventory of land in each 10-year period devoted to agricultural activities (pasture, citrus, vegetables, and melons) multiplied by the estimated crop value per acre provided the average annual revenue from crop production in each 10-year forecast period.

6.1.2 Severance Tax Revenues to Local Governments

The state collects a tax on the amount of phosphate rock mined. A portion of the revenue collected by the state is returned to the counties from which the phosphate was mined. The severance tax rate is applied to the phosphate produced to derive the state tax revenue estimate. The portion of this revenue returned to each county was calculated per the formula specified in the state law authorizing the collection of the severance tax. These revenues are considered a redistribution of the revenue generated from the production of the phosphate rock.

6.1.3 Indirect and Induced Effects

The indirect and induced economic impacts were estimated using the economic modeling software IMPLAN. IMPLAN calculates economic impacts in a transparent manner using known data sources for its calculations. For this analysis, data specific to the Applicants' Preferred Alternatives and beneficiation plants in the eight counties were used. The IMPLAN data, derived from the U.S. Census Bureau and other government sources, approximates how, from where, and on what products and services various industries spend money. IMPLAN also estimates the employment effects by industry. The IMPLAN analysis was based on national transactions in 2008. This was the most recent version of IMPLAN available at the time this analysis was prepared. Regional models based on the national model are adjusted to reflect the industries in the specific region and their purchases and output or production.

6.1.4 Net Impact

The present value of the total income, value added, and labor compensation impacts were calculated for the individual or cumulative impacts of the Applicants' Preferred Alternatives and the No Action Alternative. The present value of the No Action Alternative over the 50-year period was subtracted from the various mining alternatives to estimate the impacts of the applicable mining projects. This difference between the various Applicants' Preferred Alternatives and the No Action Alternative is the net impact of the Applicants' Preferred Alternatives.

6.2 Key Assumptions Supporting the Economic Analyses

Key assumptions were applied to aid in developing the economic impact evaluations presented in this Final AEIS. The assumptions are in several broad categories, as discussed in the following paragraphs.

6.2.1 Economic Impact Model Selection

The AEIS economic analysis provides an estimate of the impacts of the alternatives on the local and regional economy. The new phosphate rock production and the associated reduction in agricultural production are the direct impacts of the alternatives. A model of the economy is used to estimate the indirect and induced impacts of these direct impacts, which include the purchase of goods and services from the local economy by the mining and agricultural companies, and purchases by their employees.

There are three recognized commercially available models that can be used for this purpose:

- IMPLAN – Impact Analysis for Planning (MIG, Inc., 2012)
- RIMS II - Regional Industrial Multiplier System (U.S. Department of Commerce, 1997)
- REMI – (Regional Economic Models Inc., undated)

6.2.1.1 IMPLAN

IMPLAN is a regional input/output (I/O) model. I/O models are based on a cross-sectional analysis of the economy that describes the transactions between the various sectors of the economy (industry, trade, services, etc.). For each sector, the purchases of supplies, services, and other inputs and sales of products and services between sectors are mapped. Assuming that these transactional relationships do not change, the mapping allows the model to predict how a change in demand in one sector will affect the demands in other sectors. IMPLAN is based on national transactions that are then regionalized based on regional purchase coefficients that estimate the portion of the total demand for a good or service in a region that is satisfied by local suppliers of that good or service. A region is defined in IMPLAN as a county or collection of counties.

6.2.1.2 RIMS

RIMS II (RIMS) is similar to IMPLAN in that it is also based on an I/O analysis. RIMS, however, is less complicated. It involves the purchase of multipliers for each sector in the region, which an analyst can use to estimate the change in output for other goods and services, employment, and income in the region, based on a change in final demand for a good or service.

6.2.1.3 REMI

REMI has been variously described in the literature as a conjoined I/O model and behavior model, or as an I/O model integrated with an econometric and computable general equilibrium model. REMI incorporates forecast changes in the regional economy over time in a "control forecast," and then runs a separate forecast that incorporates an anticipated change due to the policy decision, new industry, or other direct economic impact to the region. It uses the change from the control forecast to determine the change in output, employment, and income.

6.2.1.4 Model Comparison

Each of the I/O models includes approximately 500 economic sectors (industries), about 11 of which are mining-related, and allows users to estimate a variety of economic statistics (revenues, value added, employment, and income). Each I/O model is based on national statistics from the U.S. Bureau of Economic Analysis (BEA) and other sources, and adjusts the national information to reflect the regional economy in differing ways.

IMPLAN and RIMS are widely used by government agencies, universities, and others for similar types of economic impact analyses such as those conducted for this AEIS (Lynch, 2000). These models are relatively easy to use and transparent, with results that are replicable. In addition, their results can be explained relatively easily. One main difference between the IMPLAN and RIMS models for their use in this analysis is that the IMPLAN model allows the analyst to more readily and accurately make changes to the economy (i.e., add sectors that may not currently be in the region), whereas the multipliers for RIMS are based on existing sectors in the region. Thus, in DeSoto County, which does not currently have any phosphate mining, there would not be any RIMS multipliers for this sector. IMPLAN allows the user to modify the economy in the county to include this new sector.

REMI is a significantly more complex model that includes an I/O default option, but offers the advantage of being dynamic, with an analysis that can consider changes in the economy over time. This can also be a disadvantage because the accuracy of the projections will depend on the underlying econometric model, which is not straightforward for the user to verify or for others to replicate. For situations where the model will be used for multiple years and can be refined over time, such as for analyzing tax policies by states, these disadvantages can be overcome. The complexity of the model and associated analysis also makes explaining any resulting analysis to decision-makers and the public more challenging.

The focus of the economic analysis for this AEIS is on the direct, indirect, and induced impacts of a change in primarily just two sectors—phosphate mining and agriculture. IMPLAN was selected to perform the analysis for these reasons, as well as the study area's location in a primarily rural economy, which is not changing rapidly. In addition, the Applicants' Preferred Alternatives would contribute to sustaining employment in the industry and preventing the region from experiencing a significant contraction relative to the No Action Alternative. Thus, it is not anticipated that the Applicants' Preferred Alternatives will lead to changes in the economic structure of this region over time, a scenario that may benefit from a dynamic modeling approach.

6.2.2 IMPLAN Model and Analysis

The IMPLAN model and analysis was based on costs and revenues in 2008 dollars. Present value analysis assumes a 2.0 percent real discount rate per the White House Office of Management and Budget (OMB) 2012 Circular A-94 (OMB, 2012).

The value of production of agricultural crops from the IMPLAN model for each crop was divided by the acres of land devoted to production of those crops in the county based on a GIS analysis of the land use in each county, to derive the average revenue per acre that was applied to the forecast land use at each Applicants' Preferred Alternative, to project agricultural revenue for those mine sites.

The parcels comprising each of the Applicants' Preferred Alternatives were provided by the Applicants.

6.2.3 Mining and Reclamation Timeline and Costs

Mining operations were assumed to be complete within 4 years of the end of rock production. Reclamation was assumed to be complete within 8 years of the end of mining operations in accordance with Florida law. A reclamation cost of $8,015 per acre was assumed based on information from the FDEP Bureau of Mining and Minerals Regulation: Mandatory Reclamation Financial Assurance Requirement MOA Contouring Not Complete, for 2008 (FDEP, Updated December 13, 2012). Reclaimed land would be available for other uses within 8 years of completion of mining operations

6.2.4 Phosphate Revenues

Revenue per ton of phosphate was assumed to be $90.78, which is the average from 2009 through 2011 for United States imported natural calcium phosphates (U.S. Department of Commerce Bureau of Census, Commodity 2510). Table 4 shows the estimated phosphate produced in tons per acre; the rate varies by mine. The value of 7,858 tons per acre was used for existing mines based on the weighted average of permit applications for the four Applicants' Preferred Alternatives.

TABLE 4
Phosphate Production in Tons per Acre
Central Florida Phosphate District, Florida

Mine	Tons per Acre Mined
Desoto	6,453
Ona	9,139
Wingate East	11,726
South Pasture Extension	8,035
Existing Mines	7,858

6.2.5 Beneficiation Plants

It was assumed that two new beneficiation plants would be constructed during the first decade of mining, one for the Desoto Mine and the other for the Ona Mine. In addition, the individual mine analyses for the Pioneer and Pine Level/Keys Tracts assumed that beneficiation plants would be constructed for these alternatives. However, for the cumulative impact analyses, it was assumed that the beneficiation plants constructed for the Ona and Desoto Mines would also be used for the Pioneer and Pine Level/Keys Tracts, respectively. Thus new beneficiation plants would not be constructed for the Pioneer and Pine Level/Keys Tracts for the cumulative analysis. The cost of constructing a new beneficiation plant and associated infrastructure was estimated at $1 billion, based on information provided by the Applicants.

6.2.6 Employment

The employment and employee compensation for each agricultural crop in each county from the IMPLAN model were divided by the acres of land devoted to production of those crops in the county, based on a GIS analysis of the land use in each county, to derive the average employment per acre and average employee compensation per acre, that was applied to the forecast land use at each Applicants' Preferred Alternative, to project agricultural employment and agricultural employee compensation for those mine sites.

6.2.7 Tax Revenues

Data on average annual tax revenue per acre by land use were collected from the tax assessor's offices in each county for each of the Applicants' Preferred Alternatives. Property tax revenues were projected based on mining plan land use projections and average tax rates per acre by land use for each county. The state severance tax rate was assumed to be $1.61 per metric ton in the first decade, which is the rate collected by the state for the period from January 1 – June 30, 2012. The severance tax rate was assumed to increase to $1.81 per metric ton in the second through fifth decades. The percentage of the state severance tax distributed to all of the counties with mining activities was assumed to be 12.8 percent, per legislation adopted in 2012. These revenues are shared among all of the counties in the CFPD and Hamilton County in proportion to their shares of the state's total phosphate production.

An additional 10 percent of the severance tax revenues collected by the state is distributed to counties identified as Rural Areas of Critical Economic Concern (RACECs). Counties in this group include Hardee, DeSoto, and Hamilton. These revenues are shared among these counties in proportion to their respective shares of projected phosphate production.

Each county in which the Applicants' Preferred Alternatives or offsite alternatives are located collects a local option sales tax or surcharge. The mining and agricultural activities are expected to generate additional sales tax revenues for the local governments. However, these revenues have not been included in this analysis. This is a conservative assumption and has the effect of underestimating the revenues to local governments, under both the No Action Alternative and the Applicants' Preferred Alternatives.

6.2.8 Land Use

For the Applicants' Preferred Alternatives, the post-reclamation land use was based on a GIS analysis of the Applicants' post-reclamation land use plans. For existing mines and the offsite alternatives, it was assumed that 40 percent of the reclaimed land would be used as pasture after reclamation. This estimate likely underestimates the amount of post-mining lands that would be devoted to agricultural pursuits, having the effect of underestimating the value of post-mining agricultural production and reducing the net economic impact of the Applicants' Preferred Alternatives.

The amount of acreage on each of the Applicants' Preferred Alternatives devoted to various agricultural and other uses was based on GIS analysis of the land use on each mine site. The initial distribution of agricultural lands on each of the Applicants' Preferred Alternatives and offsite alternatives between pasture, crop land, citrus, and other land uses was assumed to reflect the distribution of lands devoted to these crops in the county in which the mine resides. This initial distribution was based on information provided by the county tax assessor's offices.

6.2.9 Water Supply and Ecosystem Services

A significant portion of each alternative is undeveloped and lies in a natural state, as uplands, wetlands, streams, etc. These natural lands provide a number of ecosystem services that have value from an economic perspective. These services include those provided by wetlands, for example, which contribute to surface water supplies, help filter or naturally treat the water, help recharge groundwater supplies, and provide habitat for fish and wildlife.

The intent of the economic analysis of these ecosystem services was not to estimate the value of these services, but rather to describe these services, and as practicable estimate the physical change in these services (such as change in air quality, noise levels, groundwater recharge, etc.) under each alternative.

Chapter 4 described the current conditions, described anticipated physical changes that would result under each of the Applicants' Preferred Alternatives, and to the extent practicable quantified the physical impacts (acres of wetlands impacted, changes in water quality, etc.). It is often difficult to place a market value on these services because there is no active market for aesthetics, wildlife habitats, and so on. While a number of methods have been developed to try to estimate the value of these services, they often require extensive data collection, surveys, or sophisticated economic modeling, and the accuracy of results is often questioned. The analysis of the ecosystem impacts focused, therefore, on qualitatively describing these economic impacts.

Chapter 4 of this AEIS summarized the findings of the projected impacts of the Applicants' Preferred Alternatives and offsite alternatives on surface water, groundwater, water quality, ecological resources, and land use and recreation. The findings showed that while the impacts were major prior to mitigation, with mitigation the ecosystem impacts were minor to moderate with the exception of Listed Species, which with mitigation had an insignificant effect. Based on this information, it was determined that a qualitative description of these impacts was sufficient. Similarly, the cumulative impacts on these ecosystem services while major with no mitigation were minor to moderate with mitigation; as a result, a qualitative description of these impacts was deemed appropriate.

6.2.10 Water Resources

It was assumed, based on hydrologic modeling, that there would be no substantive reductions in flows that would affect recreational uses of surface waters. Also, based on the mitigation framework that would be applied by the USACE to avoid, minimize, and/or restore or otherwise compensate for stream and wetlands losses, this mitigation credit would be adequate to compensate for the debit incurred by mining and other phosphate operations. Therefore, there was no basis for evaluation of economic impacts to these resources.

6.2.11 Other Assumptions

- Four Corners Mine is equally distributed between Polk, Hardee, Manatee, and Hillsborough Counties.
- Land that is currently used in agricultural production or is in a natural state that is not mined would continue in its current use until mined.
- Hamilton County phosphate production was assumed to be 3.1 million short tons annually, which is the average annual production of the Swift Creek mine (the only mine currently operating in Hamilton County). While Hamilton County is not in the study area, its phosphate production does affect the total severance tax revenues collected by the state, and the portion of these revenues returned to the counties in the CFPD.

6.3 Economic Evaluation Results Format

For each scenario analyzed, the direct economic effects calculated included the value of phosphate rock and agricultural product revenues generated for each of the evaluated decades. The associated severance tax and subsequently the portion of this tax returned to the applicable county were calculated, and the estimated property tax accrual to the county was accounted for. The IMPLAN tool was applied to each decade-based analysis to estimate the overall indirect and induced economic effects of the calculated direct revenue productivity. IMPLAN provided estimates of employment generated by the direct impact totals by decade, and the estimated indirect and induced employment, labor income, value added, and revenue increases associated with the changes in phosphate and agricultural productivity over time. The results are presented as summary tables in Appendix H, presenting the direct impacts calculated and the net present value assessment of the overall effects of the scenario with and without the subject mine. More detailed breakdowns of the direct, indirect, and induced impact estimates for each analysis for the applicable decade are provided in Appendix H.

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Appendix C:
Replacement Pages for Appendix G

Surface Water Hydrologic Impact Analysis for the Final AEIS on Phosphate Mining in the CFPD

PREPARED FOR: U.S. Army Corps of Engineers, Jacksonville District

COPY TO: U.S. Environmental Protection Agency
Florida Department of Environmental Protection

PREPARED BY: CH2M HILL

DATE: April 10, 2013; revised June 25, 2013

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Contents

1.0 Introduction

The U.S. Army Corps of Engineers (USACE) is conducting investigations to support an Areawide Environmental Impact Statement (AEIS) focused on new phosphate mining applications submitted by Mosaic Fertilizer, LLC (Mosaic) and CF Industries, Inc. (CF Industries) within the Central Florida Phosphate District (CFPD). This technical memorandum (TM) addresses the anticipated surface water hydrological effects of each of the four Applicants' Preferred Alternatives for new phosphate mine projects, Desoto (Alternative 2), Ona (Alternative 3), Wingate East (Alternative 4), and South Pasture Mine Extension (Alternative 5) on watershed discharge to the study area surface waters.

The USACE has received and is processing Clean Water Act Section 404 permit applications for these four Applicant Preferred projects, and they are considered individually as alternatives and are the primary focus of the overall AEIS analyses. As required by the National Environmental Policy Act (NEPA), other alternatives have been identified for consideration and include four offsite alternatives for more detailed evaluation in this AEIS (see Chapter 2). These four alternatives include two that Mosaic has identified as projects that could likely be pursued within the general planning horizon of the next 50 years. They are the Pine Level/Keys Tract (Alternative 6), which could be a stand-alone alternative but will be considered in the cumulative impacts discussion as an extension to the Desoto Mine, and the Pioneer Tract (Alternative 7), which also could be a stand-alone alternative but is also considered in the cumulative impacts discussion as an extension of the Ona Mine. The other two offsite alternatives are identified as Sites A-2 (Alternative 8) and W-2 (Alternative 9) and are not considered to be in the 50-year planning horizon by either Applicant but serve as independent alternatives for further evaluation in this AEIS. However, these latter two alternatives were not evaluated in detail because they are not considered to be reasonably likely to be mined in the planning period and only qualitative information is available for these locations. In any event, their expected hydrologic impact would be similar to those evaluated for other alternatives. Their hydrologic impact as offsite alternatives is included and discussed qualitatively in Chapter 4 of the AEIS but not included as part of this detailed quantitative analysis in this TM.

The locations of the each of the four Applicants' Preferred Alternatives in relation to the Peace River and Myakka River watersheds are shown in Figures 1 and 2, respectively. Three of the sites of the Applicants' Preferred Alternatives (Desoto, Ona, and South Pasture Mine Extension) are primarily in the Horse Creek and Peace River at Arcadia subwatersheds of the Peace River watershed. The site of the fourth Applicant Preferred mine (Wingate East) is primarily in the upper Myakka River subwatershed of the Myakka River watershed. The Pioneer Tract alternative is south of the Ona Mine location (Figure 1). The Pine Level/Keys Tract alternative is west of the Desoto Mine location (Figure 2). Accordingly, this surface water hydrologic analysis primarily focused on the specific subwatersheds where the mines are within the AEIS study area.

The main goal of this assessment was to address the sensitivity of the overall river watersheds and the affected tributary subwatersheds to the impacts of each of these four individual Applicants' Preferred Alternatives on average rates of watershed discharge to downstream reaches of the systems where they are located. The potential cumulative impact of the Applicants' Preferred and two reasonably foreseeable future offsite alternatives on stream and river annual average flows was also predicted taking into account when mining activities would be expected to occur concurrently during the projected life cycles of the various mine projects (i.e., combined impact on surface water discharge). In addition to the average annual discharge rates, a dry year and a dry season were analyzed to address concerns raised after the Draft AEIS was published that the main effects would be realized during droughty periods and that the dry season watershed delivery could be impacted.

This TM addresses the following topics:

- Analytical approach and validation
- Land use projections
- Capture area projections within active mines
- Stream flow projections and evaluation of hydrologic effect on surface water delivery
- Low flow effects at surface water withdrawal points

FIGURE 1
Location of the Three Applicants' Preferred Alternatives (Desoto, Ona, and South Pasture Mine Extension) and the Offsite Alternatives Pioneer Tract and Alternative A-2 in the Peace River Watershed

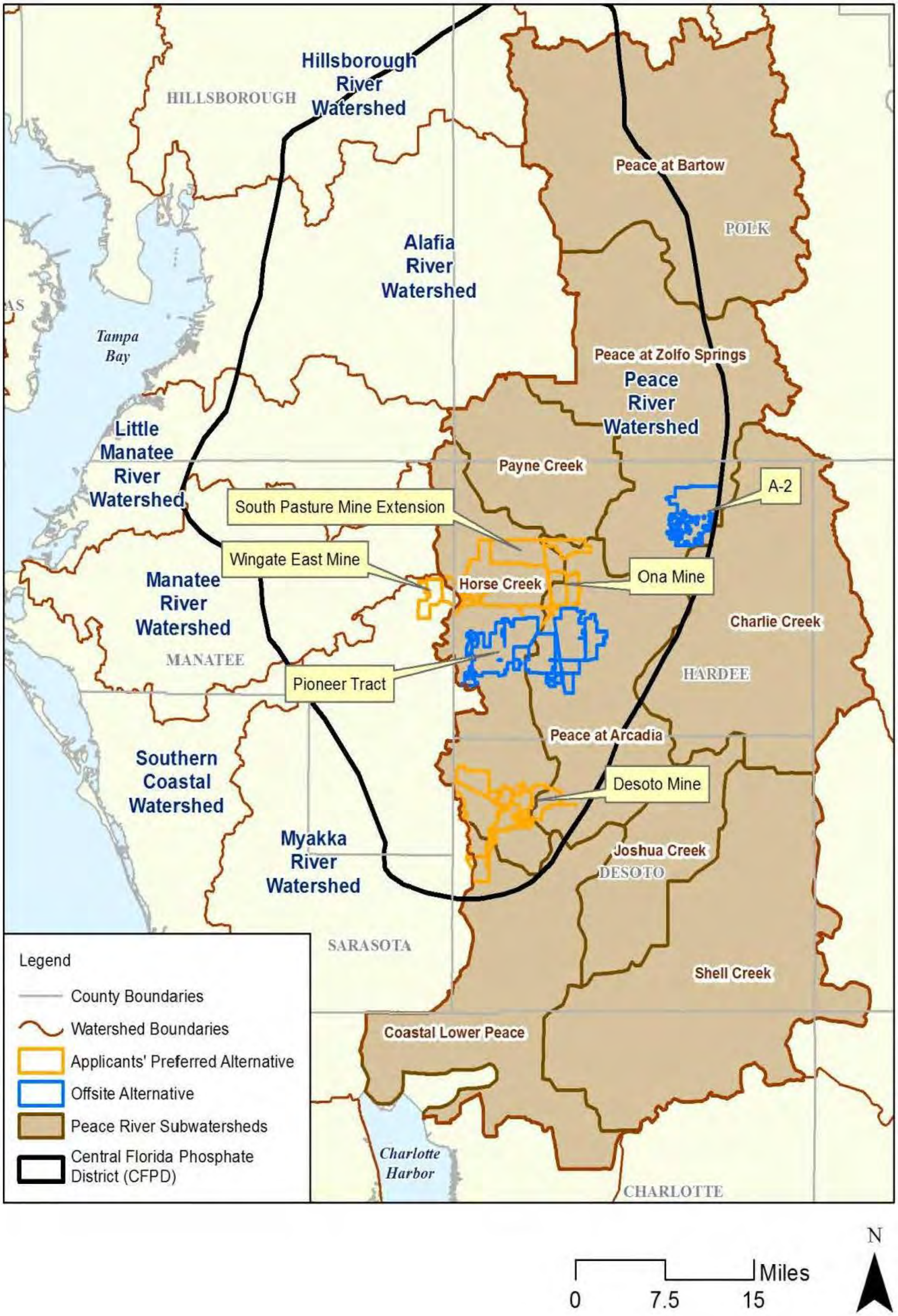
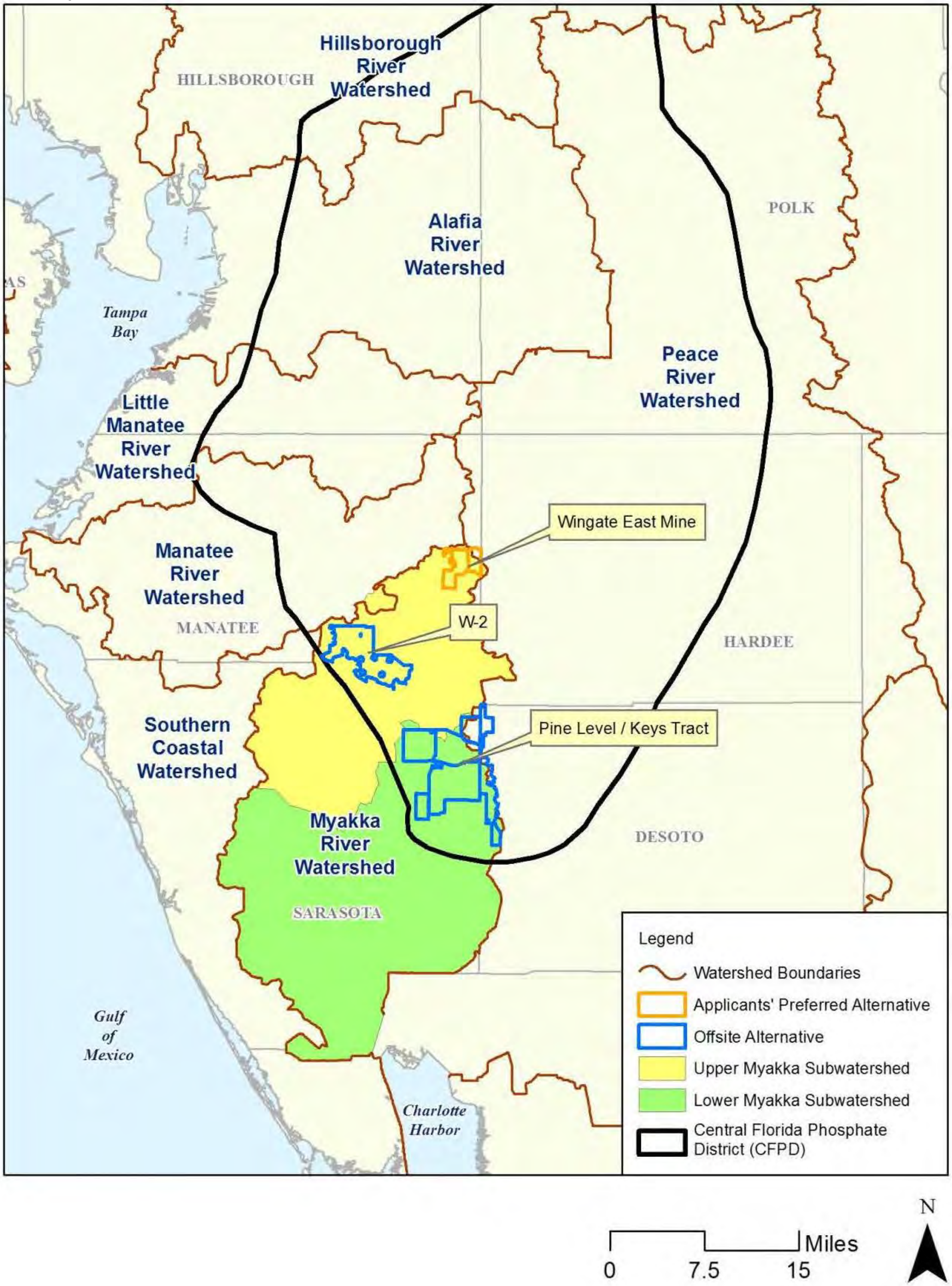


FIGURE 2
Location of the One Applicant Preferred Alternative (Wingate East) and Offsite Alternatives Pine Level/Keys Tract and W-2 in the Myakka River Watershed



2.0 Analytical Approach and Validation

The Florida Department of Environmental Protection's (FDEP) application analyses typically address the adequacy of the water management system to provide stormwater management aligned with event-based design storms. The AEIS evaluations, in contrast, are more aligned with addressing the potential long-term effects at different times in the future. The mining activities effect on water contribution to the applicable subwatersheds and/or overall river watershed where the subject mine site is located is of prime concern here. Where multiple mine projects are within the same subwatershed or river watershed, the long-term cumulative hydrologic effects of these multiple projects during their periods of overlapping operations must be evaluated. In general, the AEIS is a more regional analysis looking at trends and the relative magnitude of mining effects on the overall water balance, while more detailed evaluations specific to the mine sites are required in the permitting process by the various agencies. The results of the AEIS will be used to determine if there is a reasonable need for further evaluations in the federal permitting process.

Over the 100+ years of phosphate mining in the CFPD, the management of surface water during the mining phase has substantially changed. The management methods that would be used in the Applicants' Preferred projects are very similar to those currently being used on active mines. Practices prior to the 1980s (approximately) are not indicative of future activities. For future mines, each of the Applicants proposes to use the same conservation practice that currently minimizes groundwater withdrawals—namely, the capture, retention, and use of stormwater. During phosphate mining, much of the direct rainfall on a given active mine area is captured and held within a mine's recirculation system, consisting of a network of open-channel ditches and canals, clay settling area (CSA) impoundments, and a network of pipelines used for water/matrix/sand/clay slurry conveyance. Following capture, the stormwater is used and reused to support these onsite settling, water use, and conveyance functions[1], supplemented with groundwater as needed. The capture and use of stormwater in lieu of groundwater was a direct result of the 1978 USEPA Areawide EIS (USEPA, 1978a and 1978b) and has been the standard practice for phosphate mining since then.

The AEIS uses the terms *active mining area* and *captured area* synonymously when discussing surface water impacts. Specifically, stormwater falling on areas that are mined is controlled and managed under a National Pollutant Discharge Elimination System (NPDES) permit until FDEP approves the release of the areas after reclamation is completed. As a result, there tends to be less direct runoff from active mines and more control structures that make peak runoff rates (i.e., offsite flood contribution from larger storms) during mining less of a concern. For the AEIS, a reasonable quantification of the potential reductions in the seasonal offsite flow rates during active mining was developed to evaluate the reduction of runoff that may occur on a long-term average basis. This approach also supported the assessment of the cumulative impact from multiple mines on net downstream water deliveries for the subwatersheds and for the overall river watersheds affected by each of the Applicants' Preferred Alternatives. Peak flooding impacts during large storms were not a significant AEIS consideration, as these effects are already evaluated and controlled during active- and post-mining conditions.

2.1 Analytical Goals

The methodology applied to assess surface water runoff changes resulting from mining operations must meet the following goals:

- Account for runoff differences between different soils and land uses.
- Support analyses of impacted subwatersheds as well as the overall river watersheds where the subject mines are located.

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[1] Water demand is not primarily required for the transportation of material by slurry pipelines. Onsite surface water is consumed (lost) in processed ore product, seepage, or to ET. Water is stored onsite to facilitate the settling of solids and to mitigate potential onsite surficial groundwater dewatering impacts to adjacent wetlands and streams with the ditch and berm system. These process and ET losses would occur whether the ore is transported hydraulically or by an alternative means. The small quantity of groundwater pumped for lubricating the pump seals becomes part of the onsite water inventory. Prior to the current practice of capturing stormwater (pre-1970s), the industry used much more groundwater and discharged after use which, in turn, artificially increased stream flow. The current practice of recycling was implemented to reduce the groundwater impacts that existed prior to the mid-1970s.

- Account for seasonal components since southwest Florida has distinct dry and wet seasons.
- Account for changes in land use, including mining, far into the future (to 2060) with reasonable accuracy.

The level of accuracy and precision of the input data needs to be consistent with these goals because the accuracy of the results will be affected similarly. For example, predicting land use change 50 years in the future is speculative, so detailed analysis of runoff from future land use is less accurate the further in time one predicts (future land use is discussed later in this TM). There is a variety of information derived from the literature review of past work that needs to be taken into account when considering the AEIS analysis approach, some of which is summarized below:

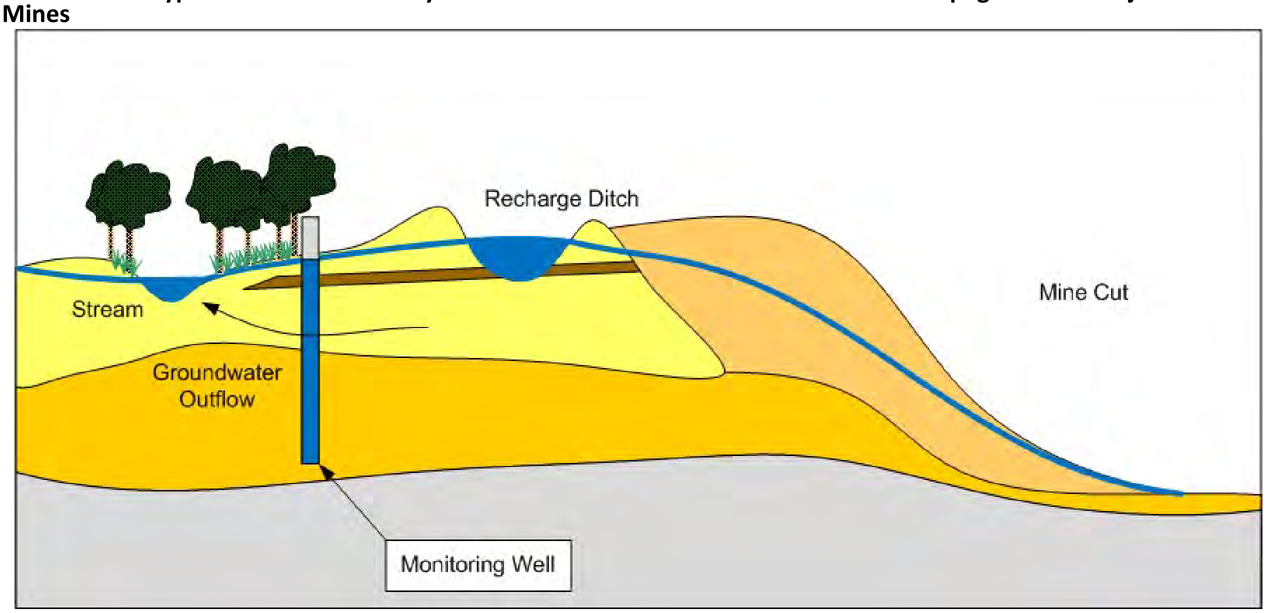
- The overall total area of active mining changes during the study period, with active mining occupying up to approximately 30,000 acres at any one time. Historic data and previous evaluations of existing watershed runoff found in the literature include the effects from 20,000 to 40,000 acres of existing or recent mining activities in the record. The Applicants' Preferred mine plans would not increase the total area of active mining in the CFPD, but the projects would affect different locations.
- Retention, groundwater seepage, and release of surface water in recent history should be reflected in the observed data record proportional to the amount of active mining occurring in that contributing subwatershed.
- Ditch and berm systems at mines help to maintain hydration and provide some low flow (also known as baseflow) in the upper tributaries of the riparian systems that are not mined and adjacent to capture areas. So, low flow conditions should not be severely impacted by mining activities, at least adjacent to the rehydration areas (see Figure 3 for a schematic of this type of system). While the groundwater table (blue line in Figure 3) is lowered in the open cuts (dewatered), the recharge ditch keeps the groundwater outflow (arrow in Figure 3) positively seeping back to the adjacent wetlands and streams and to generally help maintain groundwater levels in adjacent offsite areas. Because of local variations in soils, the effectiveness of the ditch and berm system may vary. The FDEP requires monitoring wells to determine system effectiveness. During low flow periods, baseflow in intermittent streams may seep back into the ground further downstream.
- Actively mined lands must reclaim blocks within a given time schedule. Mined land is not released from the Environmental Resource Permit (ERP) unless the reclaimed land characteristics are similar to pre-mining land conditions of the same type according to the mine reclamation plan. FDEP guidelines used for permitting CSAs require that:
  - Post-reclamation discharge volumes not exceed by more than 5 percent, nor be less than 85 percent, of pre-mining discharge volumes as simulated for the 25-year return storm event.
  - Post-reclamation peak discharges not exceed the peak discharge for pre-mining conditions as simulated for the 25-year return storm event.

These event criteria may not create similar long-term runoff characteristics. One study of CSA runoff and long-term settling (Reigner and Winkler, 2001) indicates that these criteria tend to cause teams to over-design the post-reclamation storage in the CSAs. For example, in the CF Industries South Pasture Mine Extension application (CF Industries, 2010b) the pre- and post-reclamation water balance indicated that more rainfall is retained in the surficial aquifer post-mining. Both of these documents note that rainfall infiltrates the surface layer of reclaimed soil and then flows in the surficial aquifer system (SAS). While direct runoff from the site is reduced, the ultimate disposition of this SAS water is a delayed baseflow response in the watershed from this area because deep percolation does not change. This is discussed further below under the topic of low flows (Section 6).

- The Southwest Florida Water Management District (SWFWMD) and others have extensively characterized flows in the subwatersheds, changes in flow over time, and various effects on runoff. A main conclusion from these studies is that the runoff rates are highly correlated to precipitation. Karst features in the upper Peace River watershed are primarily between Bartow and Fort Meade, such that there is a high degree of interaction between the upper Floridan aquifer and surface water (Metz and Lewelling, 2009). In fact, the upper Floridan aquifer tends to contribute to baseflow further south in the watershed where the potentiometric surface starts to approach the ground surface.

- No gypsum stacks are proposed in the watersheds where the Applicants' Preferred mine sites are located; the existing stacks are associated with the fertilizer and chemical plants and not the mines.
- Previous computer simulation results in these watersheds varied from observed data as follows: from 10 to 17 percent during the calibration of the Peace River Integrated Model (PRIM) during low flow conditions (MODHMS[2]; Evans, 2010); about 10 percent for Charlie Creek for all flows (MIKE SHE; Lee et al., 2010); and from 3 to 20 percent at locations in the upper Myakka River on an average annual flow basis (MIKE SHE; Interflow Engineering, LLC [Interflow], 2008a). This range of variability is not uncommon for any long-term hydrologic simulation project regardless of modeling approach.
- Critical low flow periods may vary year to year and the range of observed flows at the U.S. Geological Survey (USGS) gages in the Myakka River and Peace River watersheds is large. Most literature divides the discussion of runoff between dry and wet seasons as defined by the long-term data averages (monthly). Peninsular Florida (including the CFPD) has different wet and dry seasons than areas further north.

FIGURE 3
Schematic of Typical Ditch and Berm System to Maintain Groundwater Levels and Seepage to Land Adjacent to Active Mines



Modified from Garlanger (2011)

- Climate change effects on long-term precipitation rates are uncertain and speculative. In general, researchers tend to assert that the long-term average precipitation would continue to change only slightly in Florida; perhaps a slightly lower average annual rainfall will result from higher temperatures, but precipitation could become more variable with an increase in storm intensity (Fernald and Purdum, 1998b; Karl et al., 2009). Consequently, recent estimates of rainfall are sufficient (see Attachment A for local data summary). Sea level effects are documented by the National Oceanic and Atmospheric Administration (NOAA) and may affect the estuaries' salinity regime in the future. Rising sea level effects on the downstream estuaries are not within the scope of the AEIS.

[2] MODHMS, used for the PRIM model, is based on a vendor's proprietary software (HydroGeoLogic, Inc.) and it is not a widely used program. MIKE SHE is another vendor's integrated surface water and groundwater computer model that also has been applied to portions of the CFPD. MIKE SHE is a commercially available simulation program from DHI Water & Environment and has been applied in more locations in Florida than MODHMS to date (opinion based on local knowledge).

2.2 Brief Overview of Available Simulation Modeling

As noted above, a variety of reports, summaries, and other modeling efforts are available in the literature for the Peace River and Myakka River watersheds. This section provides a brief summary of a review of available types of models and their applicability to this evaluation. However, there are a few constraints that are common to any approach selected:

- Future land use data are not available out to 2060 (i.e., 50 years).
- Not all future offsite alternative plans are known. Evaluations of impacts to these alternatives are based on typical mining practices and not on a specific plan by an applicant.
- Post-mining soils are highly disturbed, but the overall porosity of the surface (to a depth of approximately 20 feet) remains similar because of the presence of overburden, which has the same sand/silt/clay content as the original soil. Although hardpan layers may be broken, these impervious layers in the SAS are not so extensive that they isolate the surface layers from the lower layers in the Applicants' Preferred Alternatives. The same statement is true for various horizons of soil with varying clay content. CSAs do have low permeability, but their area of low percolation averages out over a larger mine footprint with the sandy soils near the NPDES discharge points. Little direct literature is available to demonstrate changes resulting from mining at small scales; so the AEIS team must rely on permit criteria, compliance data, and computer simulation results.

The model review summary is divided into the following categories: integrated models, dynamic models, continuous watershed models, and steady-state models.

2.2.1 Integrated Models

(Examples: MODHMS, MIKE SHE, IHM/USF)

- Integrated models either have not been finalized at the time of the AEIS evaluation or developed for the entire Peace and Myakka River watersheds contributing to the upper Charlotte Harbor. The PRIM model was requested from the SWFWMD, which stated that this application was still under development at the time that the AEIS work was being conducted. Scenarios modeled in PRIM did not include the Applicants' future mining plans or the offsite alternative mines' land uses. The PRIM model does not simulate the hydrology of active mines directly, and the mines' net effects are part of the input data (i.e., NPDES discharge data are entered as a point source time series; HydroGeoLogic, Inc. [HGL], 2012b). Additional areas to be added are un-gaged and would therefore be uncalibrated (a minor issue).
- Soil runoff, storage, and topography are averaged over a grid unit. Model grid size varies among the watershed models currently completed, so the ability of each model to represent the landscape varies too. The PRIM model used a grid size of 2,500 x 2,500 feet (about 143 acres, or ¼ square mile [mi^2]) and the upper Myakka model grid size is about 410 x 410 feet (about 4 acres) in size. The upper Myakka River model report (Interflow, 2008a) stated that the MIKE SHE model grid size is not feasible for larger watersheds because of the run times and volume of result data generated. Consequently, small landscape features, like isolated wetlands, are averaged in an Integrated Model grid cell.
- Land use does not change in a computer model over time. A model is set up with one land use/soil characterization and then multiple years of precipitation are simulated. Therefore, multiple simulations are required to estimate the runoff for various land uses (mining scenarios). This is no different from any of the other approaches discussed below. Consequently, there is not an inherently different approach for representing the change of land use in integrated models that would represent the dynamic changes occurring to the landscape over the life of the mines.
- Land use is entered via a geographic information system (GIS) format, and future land use is not available in this format. Future topography in a GIS format is also not available and one would have to assume no major changes to existing aerial topographic data (i.e., light detection and ranging, [LiDAR]) or create new

landscapes for post-mining conditions. CF Industries included a post-reclamation landscape terrain in its permit application.

- Even if new models were developed, there would be a high level of uncertainty given the speculative basis for predicting land use change and rainfall out 50 years. Additionally, developing and finalizing new models, including recalibration, peer review, and production runs, would likely extend the AEIS schedule at least 3 to 5 years. In summary, the previously developed integrated models were not available to the AEIS team, it would take significant work to adapt them for the AEIS evaluation, and the degree of uncertainty in the results would remain high. The uncertainty associated with future land use changes would apply to any approach selected.
- These types of models are very resource-intensive to run; computer run times are long, about 12 to 16 hours per year simulated. Massive data and result files are generated and considerable effort is required to reduce results into formats that may be useful.

2.2.2 Dynamic Models

(Examples: SWIM, ICPR)

- Dynamic models are primarily used to route stormwater through a system of pipes, streams, and rivers with a higher confidence in peak flow rates and stages. These programs are often used for storm event simulations, but can be used for longer precipitation records (i.e., continuous time series simulation). The hydrology prediction algorithms used for a continuous simulation are often different than those used for storm event modeling. Long-term simulations require calibration and verification of runoff rates and volumes for application to projects.
- There is a need to average (lump) parameters to the subwatershed level for input. Stage storage relationships are needed for each subwatershed (LiDAR could be used for some of this). Cross section data, of at least the river and stream crossings, are also required input and LiDAR data are normally not sufficient for these inputs. SWFWMD guidelines for watershed models require delineation into very small contributing subwatersheds and a substantial amount of data for input. (These subwatershed areas are still typically larger than the grids in Integrated Models.)
- Dynamic models are resource-intensive to develop; less so than integrated models, but could take at least 2 to 3 years to develop. Previous SWMM models may have been prepared for the Peace River Cumulative Impact Analysis, but new models are required to be developed for the entire Myakka River watershed and for the future mines.
- These models are resource-intensive to run; computer run times are long, about 3 to 6 hours per year simulated. In highly detailed models (i.e., small subwatersheds and many channels), run times could take twice this estimate to execute.

2.2.3 Continuous Watershed Models

(Examples: HSPF, SWAT)

- This class of models uses simpler flow routing to move water through the watershed. Stage storage relationships are needed for each subwatershed (LiDAR could be used for some of this). Input requires cross section data of, at least, some of the rivers and streams. SWFWMD guidelines for hydrologic models require very small subwatersheds and a considerable amount of data to use as input. The AEIS team may be able to relax some of the data requirements with the simpler routing methods.
- Land use data are not available out 50 years. Similar to the other approaches, input to these models averages parameters to the subwatershed level.
- These models still require model development and calibration, both of which are resource-intensive. This could take up to 1.5 to 2 years to develop fully for the AEIS project.

- These models are less resource-intensive to run simulations; run times range from about 4 to 8 hours per 3 to 5 years simulated.

2.2.4 Steady-State Models

(Examples: PLOAD, U.S. Environmental Protection Agency [USEPA] Simple Method)

- Several models could be applied, but they are very similar to the runoff coefficient approach used in the USEPA Simple Method. The main difference is how the coefficients are estimated. (Note, the Rational Method is not a water yield computation; it is used only to predict peak flow rates and the equation parameters are defined differently.)
- Similar to the other approaches, input to these models averages parameters to the subwatershed level.
- A variation of USEPA's Simple Method was applied to Charlotte Harbor pollutant load estimates. The runoff coefficient was developed based on observed data from multiple gages in the region. Both wet and dry season coefficients were developed.
- These types of models have been used to evaluate flow impacts throughout the nation, especially where there flow gage data are available. USEPA supports the model for pollutant load computations and it is a widely accepted approach in the NPDES stormwater program.
- These types of models can be implemented on a spreadsheet; however, large spreadsheets can be cumbersome. The method can utilize GIS queries to combine the soils and land use data and then export those data to the computation sheets. These models can also manipulate the effects of mining by adjusting coefficients on a subwatershed scale.
- The computation is direct (no numerical approximation) and can be done within a few hours after the sheet is set up. This approach requires approximately 2 to 3 months of effort to extract the data, set up the sheets, and prepare the output.

While some of the permit applications for mining include detailed hydrologic computer modeling results for pre- and post-mining conditions, the AEIS needs to apply estimated land use and weather patterns for up to approximately 50 years into the future with the various mines in different stages of active mining. Given the summary described above, detailed hydrologic computer modeling was not viewed as an appropriate technical approach, primarily because the inputs are highly uncertain. Rather, a method for making long-range predictions was developed using relevant existing literature and publicly available GIS data with the runoff coefficient approach with specific assumptions applied to account for the active mines (discussed in Section 2.6 and in Section 4). While this approach may not account for small-scale or short-duration hydrologic processes with high precision, the overall results achievable are appropriate for a large-scale, long-term predictive assessment of the watershed and major tributaries like what was needed to support the USACE AEIS.

2.3 Runoff Calculation Method Overview

The approach adopted for the AEIS evaluations is based on the one used for a recent analysis of pollutant loading to the Charlotte Harbor Estuary performed on behalf of the Charlotte Harbor National Estuary Program (CHNEP) by Janicki Environmental, Inc. (Janicki; 2010). The evaluations conducted for the CHNEP combined the hydraulic evaluations of watershed runoff with water quality information to generate pollutant load estimates. For the AEIS evaluations, the method adopted was based on the hydraulic aspect of the overall pollutant loading analysis. This methodology was also applied for the Tampa Bay Estuary Program (as stated in Janicki, 2010). This approach was favored because the coefficients were calibrated using recent data throughout the same region as the AEIS. The runoff coefficient computations could be executed with commonly available spreadsheets utilizing readily available GIS data.

Runoff amounts resulting from the rainfall on the land are calculated taking into account a combination of factors, including: watershed and subwatershed boundaries (acreages), land uses, and soil hydrologic groups. The combination of land use and soil types can be used to develop land use-specific runoff coefficients. Janicki (2010) developed the runoff coefficients from USGS gage data utilizing monthly unit runoff rates (cubic feet per second per square mile [cfsm]) divided by monthly precipitation (inches per month). Using land use coverage and literature values as a start, the runoff coefficients were varied to achieve a relatively good fit of the predicted runoff to the reduced observed data; the report stated that the correlation coefficient (r^2) was 0.87. As noted above, the data utilized incorporated current effects of existing mining so the capture and delayed release, or losses, associated with phosphate mining are implicitly included in the calibration of the runoff coefficients. Specific coefficients for mining land use were developed in this report.

For any given watershed, the flow for a given seasonal or annual period can be calculated by applying the equation:

$$Q = C_d * A * P * j * k$$

This equation is part of a pollutant load equation, sometimes called the USEPA Simple Method, as discussed above, is the one often used to predict the runoff component of pollutant loading estimates. For this equation:

Q is the flow in cubic feet per second (cfs),

Cd is the runoff coefficient for the contributing subwatershed,

A is the drainage area that contributes flow to the gaged location,

P is the total precipitation during the analysis frequency (annual or seasonal),

j is the long-term hydrologic adjustment factor, and

k is a factor applied for units conversion.

The runoff coefficients developed by Janicki (2010) for land areas tributary to the Charlotte Harbor Estuary were divided into wet and dry season Cd values. The CHNEP analysis estimated Cd as a function of cfsm/inches-precipitation per month. To report this value in inches of runoff per inch of precipitation, a unit conversion factor of 1.115 is required. The soil and land use are used to select an appropriate Cd. This is described in more detail below.

For the Peace and Myakka River watersheds, the average rainfall totals were 50 and 53 inches per year (in/yr), respectively. In addition to the average year, a dry year was also simulated. This value was taken as the low 20th percentile value (i.e., 80 percent of the annual rainfalls exceed this value[3]), or 43 in/yr for both Peace and Myakka River watersheds. The low rainfall value is approximately the same condition used by the SWFWMD to permit agricultural water use. The rainfall data are provided in Attachment A, and P20 values are the 20th percentile rankings. Seasonal values are determined by summing the monthly precipitation values during the respective wet (June through September) and dry seasons.

The USGS maintains flow recording gages at or near the downstream ends of each of the major tributary subwatersheds shown in Figures 1 and 2. The runoff calculation method applied in the AEIS was calibrated to the subwatersheds of interest by using historical rainfall records and GIS-based data regarding AEIS study area[4] subwatershed boundaries (and acreage), soil hydrologic types, land use information, and land use-specific runoff coefficients to calculate annual flows in five subwatersheds defined by the USGS gage stations (Janicki, 2010). The referenced long-term hydrologic adjustment factor in the governing equation was used as a calibration term in the AEIS runoff estimation approach to improve the estimates of the specific subwatersheds in the AEIS study area. In general, *j* is used to account for a variety of influences on the retention and storage volume within a watershed (for example, either in lakes and reservoirs or in the subsurface soil layers) and it varies between subwatersheds and with rainfall amount (i.e., wet year or season versus dry year or season). The unit conversion factor described above

[3] Different reports use the percentiles in opposite ways. Sometime a 10th percentile represents the highest 10 percent (Garlanger, 2002), while others use the 10th percentile to represent the low flows (HGL, 2012a). The P20 nomenclature in Attachment A generally follows the EXCEL function for reporting the lowest 20th percentile value.

[4] As mentioned earlier, the AEIS study area for the surface water evaluation was limited to the Peace and Myakka River Watersheds, not the entire CFPD.

(1.115) was incorporated in the *j* adjustment factor in the calibration effort, and the k unit conversion factor then just included factors to convert the runoff equation from acres-inches per year to predict flow in cfs.

The analytical method was tested against gaged flows within the Peace River and Myakka River subwatersheds to validate this empirical approach for the AEIS evaluations and to derive the adjustment factors per subwatershed. Section 2.4 describes information used to support the method development. Method validation results are summarized in Section 2.5.

2.4 Data Sources and Key Assumptions Supporting the Surface Water Analysis

The following sections address the watershed-based historical rainfall and flow records, land use GIS coverages, hydrologic soils data, and land use-specific runoff coefficients used to support this AEIS surface water analysis.

2.4.1 Rainfall

Precipitation regimes of southwest Florida are largely dominated by a summer wet season (June through September) when more than 60 percent of annual precipitation occurs due to local convective-type thunderstorm activity (Basso and Schultz, 2003). During the summer, tropical storms and hurricanes may also affect the region with extremely heavy rain and wind. During the remainder of the year, weather patterns are dominated by mid-latitude frontal systems and there is significantly less rainfall. On average, the wettest month in the region is July and the driest month is November. However, the rainfall record is highly variable and any given month could have a relatively high rainfall total or a drought period (see maximum and minimum monthly totals in Attachment A).

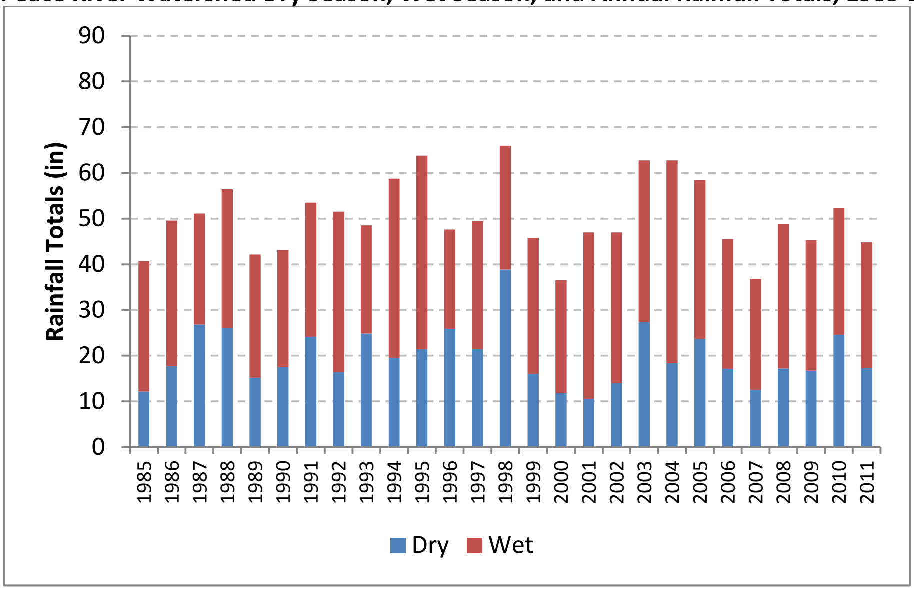
Surface water runoff is affected by rainfall variation, the time of year when rainfall occurs, and previous months' moisture conditions. Hydrologically, the landscape is driest (including the SAS) during May and into early June, just before the beginning of the summer rainy season when the previous months' precipitation is low and the early summer evapotranspiration (ET) rate is high. The months of September and October, at the end of the summer rainy season, are generally when hydrologic systems reach their annual peaks (flows and levels of both surface and groundwater systems) resulting from higher rainfall and full water storage on and below the ground surface. The month of June can be considered a transition month into the wet season and October a transition month into the fall dry season. Rainfall becomes most important in the runoff process during the months of June through October because of its magnitude, intensity, and the generally wet conditions during previous months. During the late summer rainy season, soil moisture content is highest, groundwater levels are closer to ground surface, and surface storage within the watershed decreases (for example, in wetlands and soils). This results in higher percentages of rainfall contributing to runoff and to surface water levels.

In the analytical approach development effort, the period of record chosen for calibrating the adjustment factor was related primarily to the availability of reliable data for land uses. The precipitation used for the AEIS was based on SWFWMD's rainfall database, reported by county, between 1985 and 2011 for the calibration period. Figures 4 and 5 present wet and dry season as well as annual total rainfall amounts for the Peace River and Myakka River watersheds, respectively, as summarized by the SWFWMD per the USGS drainage watersheds (SWFWMD, 2012b; see Attachment A). Normally, about 60 percent of the rainfall occurs in the wet season, which is 40 percent of the year, and there is a little more rainfall closer to the coast. As noted previously, the Peace and Myakka River watersheds have average rainfall amounts of 50 and 53 in/yr, respectively.

2.4.2 Watershed and Subwatershed Boundaries

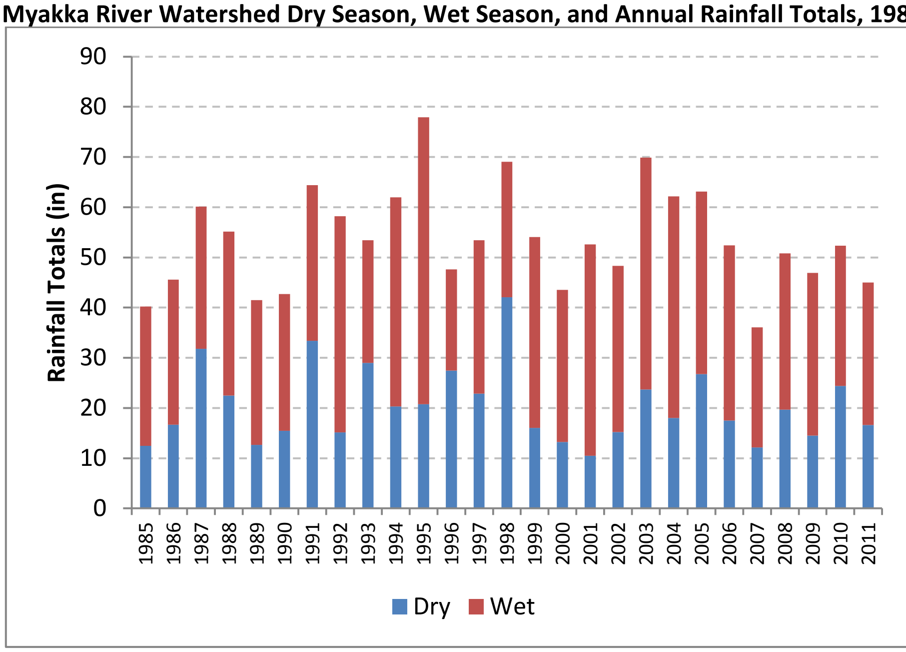
The Peace and Myakka River watersheds are divided into distinct subwatersheds defined by tributary streams and river reaches often defined by USGS gage stations. These subwatersheds were generally those used in previous reports, like the previous Cumulative Impact Studies (PBS&J, 2007 and SWFWMD, 2001b) and other hydrologic characterization reports (Lewelling and Wylie, 1993; Schreuder, Inc. [Schreuder], 2006). GIS-based data were also obtained through the USGS portal (Natural Resource Conservation Service [NRCS], 2013). The Peace River watershed is divided into nine distinct subwatersheds (see Figure 1). Of these nine, eight have USGS gage stations that measure flow continuously. Figure 6 presents a diagram of the gaged subwatersheds that contribute flow to the Peace River and Charlotte Harbor. The flow ranges and periods of record are from the Peace River Basin Cumulative Impact Study (PBS&J, 2007), but these gages continue to collect flow data.

FIGURE 4
Peace River Watershed Dry Season, Wet Season, and Annual Rainfall Totals, 1985-2011



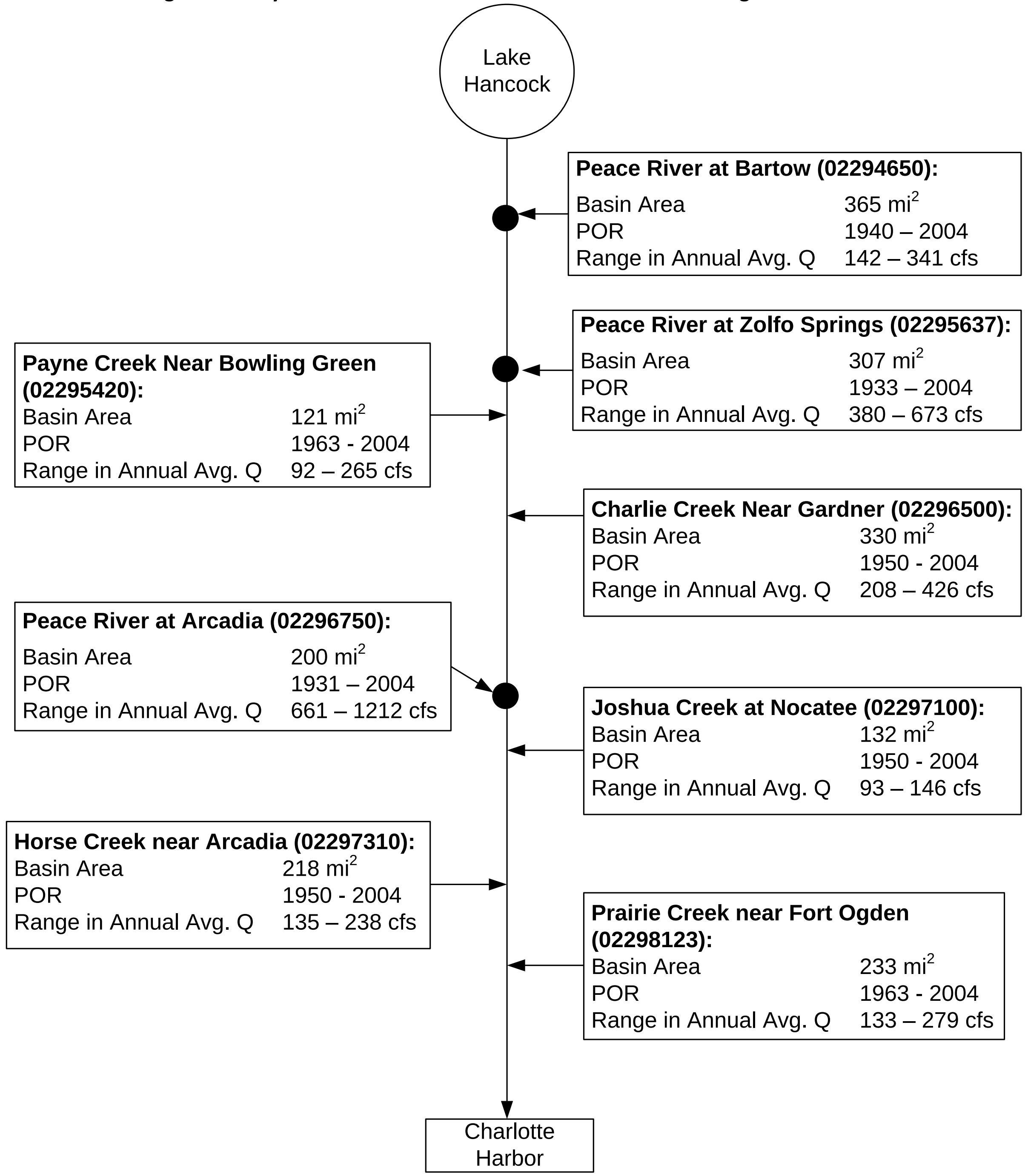
Source: SWFWMD, 2012

FIGURE 5
Myakka River Watershed Dry Season, Wet Season, and Annual Rainfall Totals, 1985-2011



Source: SWFWMD, 2012

FIGURE 6
Historical Discharge Summary for Peace River Subwatersheds at USGS Flow Gage Stations

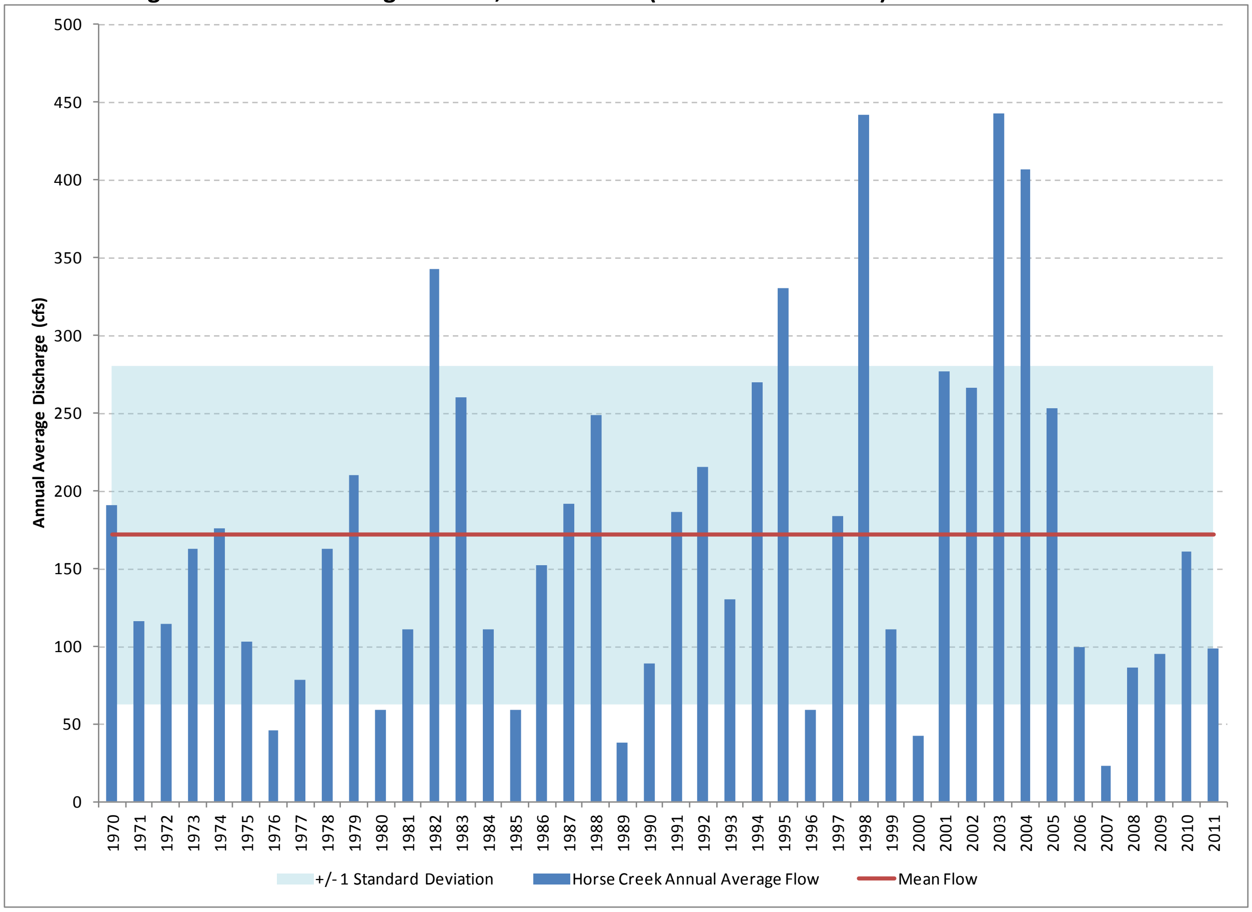


Data Source: PBS&J, 2007

As noted previously, because the Applicants' Preferred mine sites are primarily within the Horse Creek, Peace River at Arcadia, and upper Myakka River subwatersheds, the calibration effort discussion is focused on flows at these gage stations. The flow information from gage stations was downloaded from USGS databases, summarized, and used to calibrate the runoff coefficient approach for calculating stream flow within each subwatershed. The period of record used to illustrate annual flow conditions in each watershed is from 1970 through 2011 in Figures 7 through 9 that summarize annual average flows for the Horse Creek, Peace River at Arcadia, and upper Myakka River gages, respectively. These figures also illustrate the mean flows for the period of record and one standard deviation above and below the mean flows (reflected by the blue shaded areas).

FIGURE 7

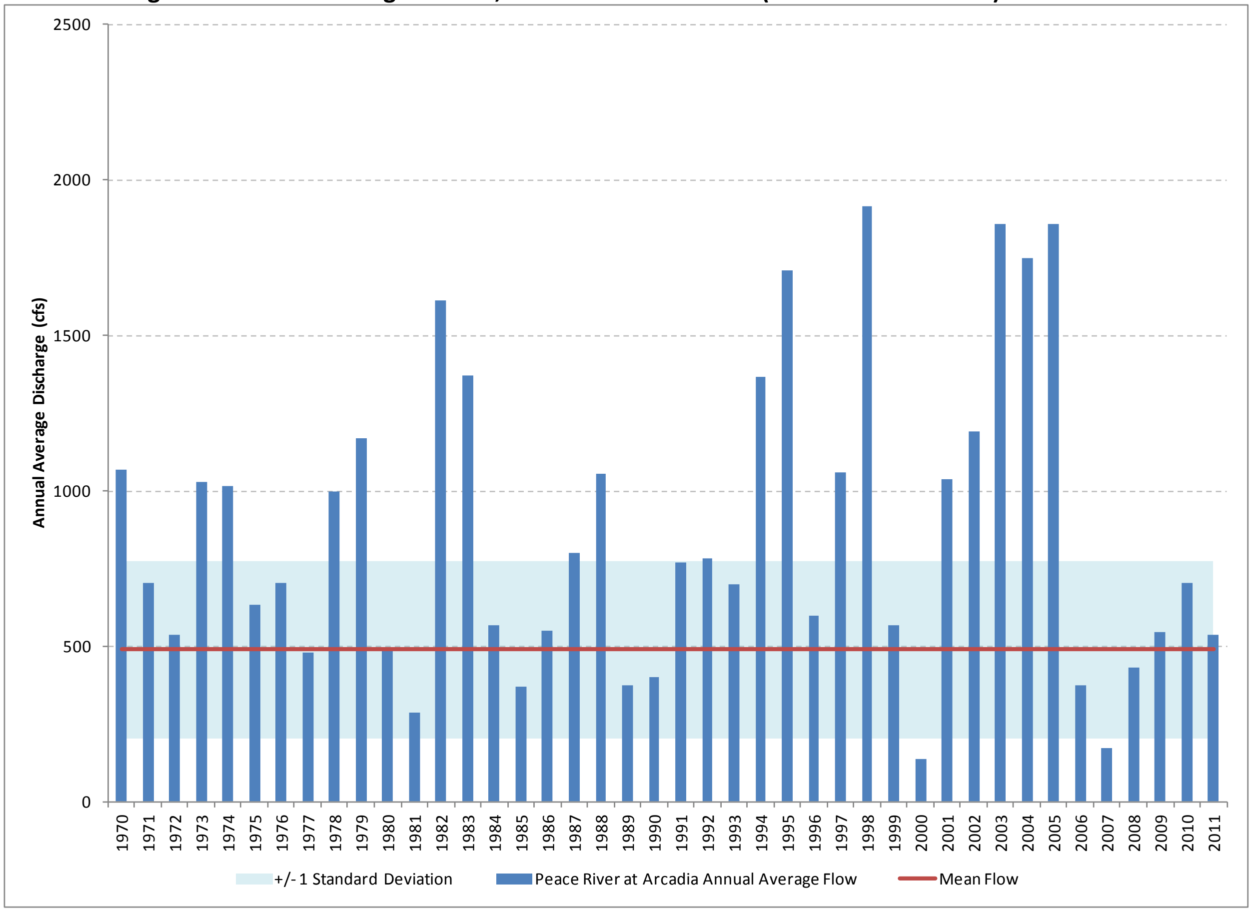
Annual Average Flows for USGS Gage Station, Horse Creek (Station ID 02297310)



Source: USGS, 2012b

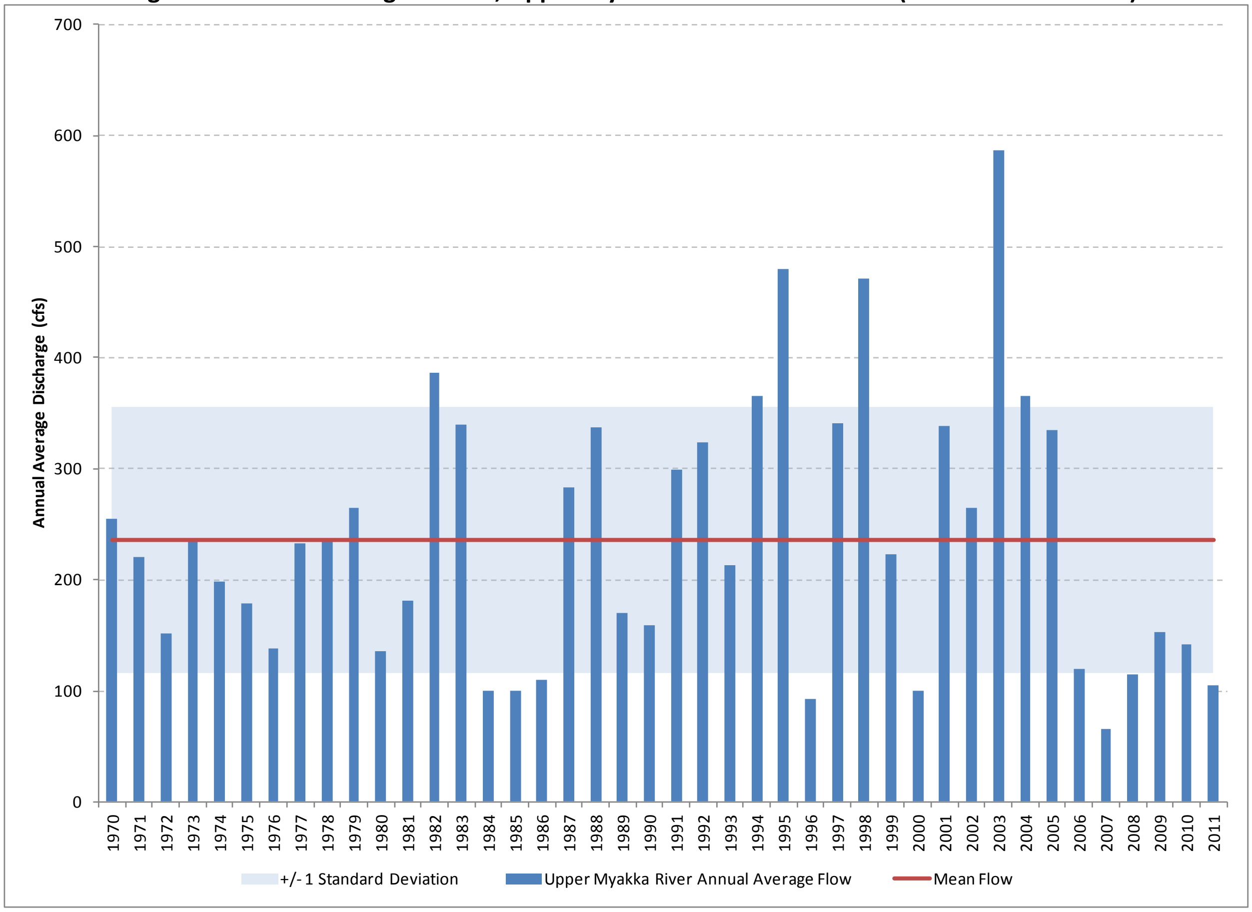
FIGURE 8

Annual Average Flows for USGS Gage Station, Peace River at Arcadia (Station ID 02296750)



Source: USGS, 2012b

FIGURE 9
Annual Average Flows for USGS Gage Station, Upper Myakka River near Sarasota (Station ID 02298830)



Source: USGS, 2012b

During the period of record (1970 through 2011), significant flow variations occurred at each of these stream gauging locations. The periods of low and high flow correlate well between these gages and also correlate well with the rainfall totals for those years. This illustrates that these streams can be considered predominantly rainfall-driven systems, as others have also indicated (Basso and Schultz, 2003; HGL, 2012c). One standard deviation above and below historical mean flow is presented to show a reasonable range of historical variation in stream flow. A standard deviation range contains approximately 67 percent of the observations in a normal distribution. A log-transformation was examined to determine whether it would yield a different result, which it did not in this case. One standard deviation was selected to use in the plots to show a relative range of flow because larger statistical ranges often reported (e.g., 90 or 95 percent) are so large; the plots would just appear to have a blue background.

2.4.3 Land Uses

The 1990, 1999, and 2009 Florida Land Use, Cover and Forms Classification System (FLUCCS) data were acquired from SWFWMD for the most recent and accurate data related to land use within the areas of interest. The trends in land use changes over this time period were examined and used to help establish future conditions (see Section 3.0). Level 4 descriptions were used in the AEIS to correlate the land use to runoff coefficients used in the CHNEP report (Janicki, 2010), although less detailed Level 1 data have been used by others when simulating these watersheds using complex hydrologic models (Lee et al., 2010; Interflow, 2008b; Evans, 2010).

The Level 4 FLUCCS description and its correlation with the land uses described in the CHNEP Pollutant Loading Report (Janicki, 2010) are presented in Table 1. Figure 10 presents the FLUCCS 2009 coverage within the CFPD as an illustrative example of these data.

TABLE 1
Land Use Description Correlation with CHNEP Pollutant Loading Report

FLUCCS Code	FLUCCS Description	CHNEP Pollutant Loading Land Use Description
1100	Residential Low Density	Single Family Residential
1200	Residential Medium Density	Medium Density Residential
1300	Residential High Density	Multifamily Residential
1400	Commercial and Services	Commercial
1480	Upland Forested Land Use	Range Lands
1500	Industrial	Industrial
1600	Extractive	Mining
1700	Institutional	Institutional, Transportation, Utilities
1800	Recreational	Range Lands
1820	Golf Courses	Range Lands
1900	Open Land	Range Lands
2100	Cropland and Pastureland	Agricultural - Row and Field Crops
2110	Improved Pastures	Agricultural - Pasture
2140	Row Crops	Agricultural - Row and Field Crops
2150	Agricultural Land Use	Agricultural - Row and Field Crops
2120	Unimproved Pastures	Agricultural - Pasture
2130	Woodland Pastures	Agricultural - Pasture
2200	Tree Crops	Agricultural - Groves
2210	Agricultural Land Use	Agricultural - Groves
2230	Agricultural Land Use	Agricultural - Groves
2300	Feeding Operations	Agricultural - Feedlots
2400	Nurseries and Vineyards	Agricultural - Nursery
2420	Upland Forested Land Use	Range Lands
2440	Agricultural Land Use	Agricultural - Row and Field Crops
2500	Specialty Farms	Freshwater - Open Water
2540	Aquaculture	Freshwater - Open Water
2550	Water and Wetlands	Freshwater - Open Water
2600	Other Open Lands <Rural>	Range Lands
3100	Herbaceous	Range Lands
3200	Shrub and Brushland	Range Lands
3300	Mixed Rangeland	Range Lands
4100	Upland Coniferous Forest	Upland Forests
4110	Pine Flatwoods	Upland Forests

TABLE 1
Land Use Description Correlation with CHNEP Pollutant Loading Report

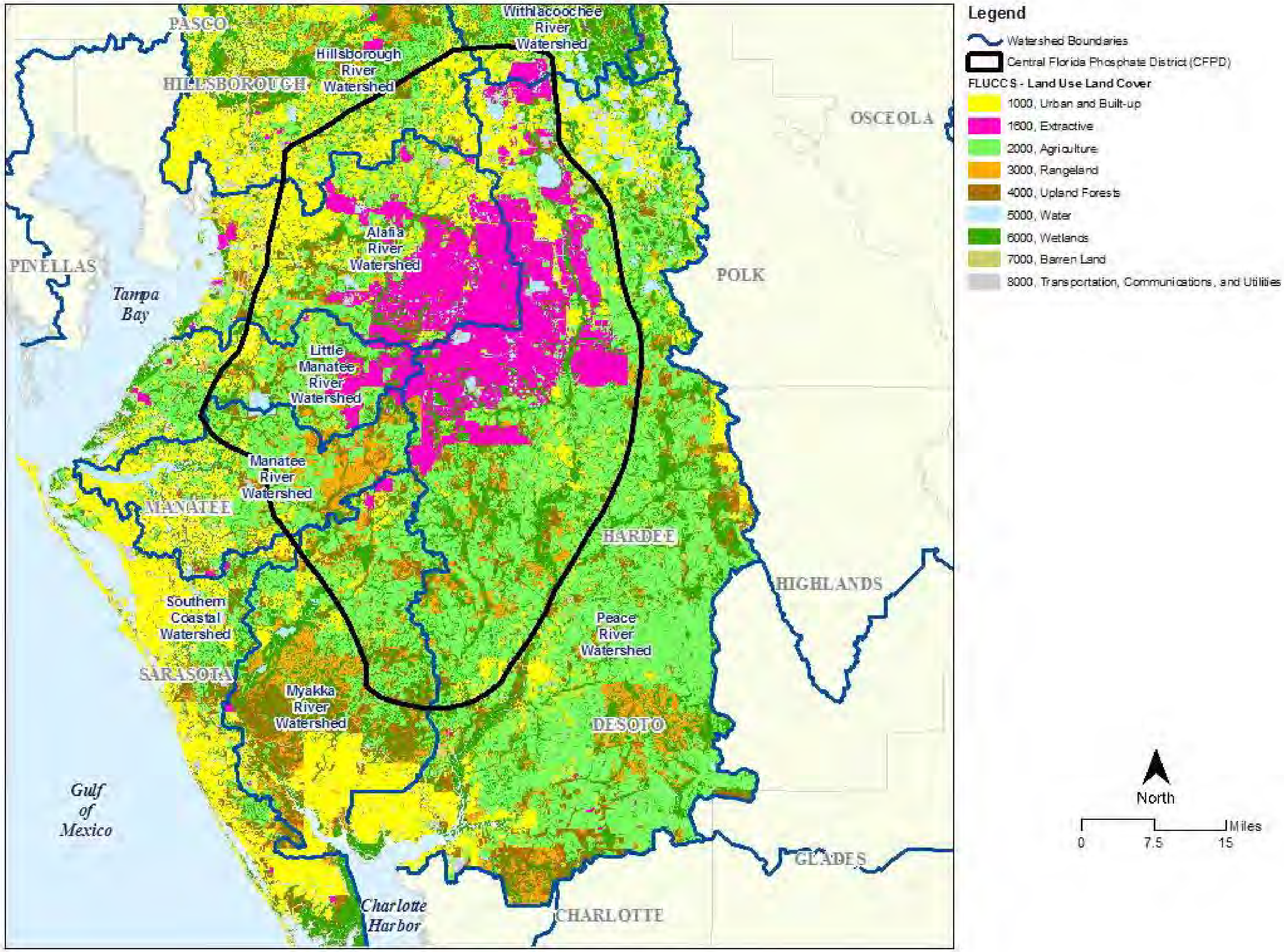
FLUCCS Code	FLUCCS Description	CHNEP Pollutant Loading Land Use Description
4120	Upland Forested Land Use	Upland Forests
4200	Upland Hardwood Forests	Upland Forests
4300	Upland Hardwood Forests	Upland Forests
4340	Hardwood Conifer Mixed	Upland Forests
4400	Tree Plantations	Upland Forests
5100	Streams and Waterways	Freshwater - Open Water
5200	Lakes	Freshwater - Open Water
5210	Lakes larger than 500 acres	Freshwater - Open Water
5220	Lakes larger than 100 acres	Freshwater - Open Water
5230	Lakes larger than 10 acres	Freshwater - Open Water
5240	Lakes less than 10 acres	Freshwater - Open Water
5300	Reservoirs	Freshwater - Open Water
5310	Reservoirs larger than 500 acres	Freshwater - Open Water
5320	Reservoirs larger than 100 acres	Freshwater - Open Water
5330	Reservoirs larger than 10 acres	Freshwater - Open Water
5340	Reservoirs less than 10 acres	Freshwater - Open Water
5400	Bays and Estuaries	Saltwater - Open Water
5500	Major Springs	Freshwater - Open Water
5600	Slough Waters	Freshwater - Open Water
6100	Wetland Hardwood Forests	Forested Freshwater Wetlands
6110	Bay Swamps	Forested Freshwater Wetlands
6120	Mangrove Swamps	Saltwater Wetlands
6150	Stream and Lake Swamps	Forested Freshwater Wetlands
6200	Wetland Coniferous Forests	Forested Freshwater Wetlands
6210	Cypress	Forested Freshwater Wetlands
6240	Cypress-Pine-Cabbage Palm	Forested Freshwater Wetlands
6300	Wetland Forested Mixed	Forested Freshwater Wetlands
6400	Veg. Non-Forested Wetlands	Non-Forested Freshwater Wetlands
6410	Freshwater Marshes	Non-Forested Freshwater Wetlands
6411	Water and Wetlands	Non-Forested Freshwater Wetlands
6420	Water and Wetlands	Saltwater Wetlands
6430	Wet Prairies	Non-Forested Freshwater Wetlands
6440	Emergent Aquatic Vegetation	Freshwater - Open Water

TABLE 1
Land Use Description Correlation with CHNEP Pollutant Loading Report

FLUCCS Code	FLUCCS Description	CHNEP Pollutant Loading Land Use Description
6450	Water and Wetlands	Freshwater - Open Water
6500	Non-Vegetated Wetlands	Tidal Flats
6510	Tidal Flats	Tidal Flats
6520	Shorelines	Tidal Flats
6530	Intermittent Ponds	Non-Forested Freshwater Wetlands
7100	Beaches other than for Swimming	Barren Lands
7200	Sand other than Beaches	Barren Lands
7300	Exposed Rock	Barren Lands
7400	Disturbed Lands	Barren Lands
8100	Transportation	Institutional, Transportation, Utilities
8200	Communications	Institutional, Transportation, Utilities
8300	Utilities	Institutional, Transportation, Utilities
9113	Sea Grass, Patchy	Saltwater - Open Water
9116	Water and Wetlands	Saltwater - Open Water
9121	Water and Wetlands	Saltwater - Open Water

CHNEP land use from Janicki, 2010

FIGURE 10
FLUCCS 2009 Land Use Map



Source: SWFWMD, 2009a

According to the most recent land use cover data (SWFWMD, 2009a), major land uses within the areas of interest in the Peace and Myakka River watersheds are *Urban and Built Up*, *Agriculture*, *Wetland*, and *Rangeland*. The Peace River watershed is composed of 42 percent *Agriculture*, 22 percent *Urban and Built Up*, and 19 percent *Wetlands*. Of the *Urban and Built Up* land use cover, approximately 45 percent is *Extractive* land use, which represents 10 percent of the entire Peace River watershed area. The Myakka River watershed is made up of 26 percent *Agriculture*, 23 percent *Wetlands*, 19 percent *Urban and Built Up*, and 13 percent *Rangeland*. Of the *Urban and Built Up* land use cover, approximately 5 percent is *Extractive* land use, which represents only 1 percent of the entire Myakka River watershed area. Extractive land use may include land that supports mining (e.g., factory, offices), other types of mines (e.g., sand), and land that is in various stages of reclamation and release; the extractive land use presented in the FLUCCS database is not just active phosphate mines.

2.4.4 Hydrologic Soil Groups

The U.S. Department of Agriculture NRCS characterizes and assesses soils for their runoff potential. This characterization is listed within four categories called their hydrologic soil groups. Hydrologic soil groups are characterized according to the water transmitting soil layer (that is, the surface layer of soil) and the depth to a seasonal water table, and are classified as A, B, C, or D. The soil types by hydrologic group layer were acquired from the NRCS and provided by the SWFWMD. Soils data in the database were mapped by the NRCS for the CFPD counties between 2000 and 2010.

Group A soils are characterized as having low runoff potential even when thoroughly wet, and where water is transmitted freely through the soil (i.e., no clayey restrictive layers). Group A soils typically have less than 10 percent clay and more than 90 percent sand or gravel and have gravel or sand textures. Group B soils are characterized as having moderate to low runoff. Group B soils typically have between 10 percent and 20 percent clay and 50 percent to 90 percent sand, and have loamy sand or sandy loam textures. Group C soils are characterized as having moderate to high runoff potential. Group C soils typically have between 20 percent and 40 percent clay and less than 50 percent sand, and have loam, silt loam, sandy clay loam, clay loam, and silty clay loam textures. Group D soils are characterized as having high runoff potential. Group D soils typically have greater than 40 percent clay, less than 50 percent sand, and clayey textures.

Some soils have combined A/D, B/D, or C/D soil group assignments. These soils have top layers that respond like the first letter when drained or dry, but have high runoff potential (Group D) when wet, normally because of high water table levels and/or restrictive flow layers. By standard practice and convention, dual groups are assumed to be Group D soils for design and permitting. However, for characterizing long-term runoff, this assumption may be too conservative, particularly in a subwatershed where interaction with groundwater is known to vary because of fluctuations in groundwater levels. For the AEIS, combined soil groups are assumed to be the initial hydrologic group (e.g., A/D were assigned A) for consistency. Otherwise, if all of the combined soils were reassigned D soils, there was less difference in the landscape and the results of the analytical approach did not match the observed gage data as well.

Table 2 presents the acreage and percent of area for each soil hydrologic group for the Peace and Myakka River watersheds. A soil hydrologic group map is presented in Figure 11 for the entire CFPD. The CFPD is categorized by having mostly sandy well-drained soils, which contribute less to runoff and surface water flows and more to infiltration, surficial aquifer interflow, and groundwater deep recharge. This is especially true in the northern portion of the CFPD with the A soils, while there are more combined groups (e.g., B/D) soils in the south. The predominant soil hydrologic groups in the CFPD are Groups A and A/D, with 30 percent and 38 percent cover, respectively. Only 5 percent of the CFPD is Group D soils, which are often associated with depressional wetlands. The coverages of B/D and C/D soils are 12 percent and 11 percent, respectively.

In the Peace River watershed, the predominant soil group is A/D, with a total cover of 49 percent. Although these are sandy soils, they are characterized as having high groundwater levels. Group A covers approximately 18 percent of the Peace River watershed. Groups B, C, and D cover only 1 percent, 0.1 percent, and 2 percent of the watershed, respectively. Groups B/D and C/D cover 15 percent and 10 percent, respectively.

In the Myakka River watershed, the predominant soil group is A/D with a total cover of 63 percent, followed by Group C/D with a total cover of 25 percent. Group A has only 6 percent coverage. With this distribution of hydrologic groups, this watershed is also characterized as having a high groundwater table and the potential for significant presence of wetlands. The runoff potential for the Myakka River watershed is high.

TABLE 2
Acreage and Percent Soil Hydrologic Groups Cover for CFPD, Peace River and Myakka River Watersheds

	Peace River Watershed		Myakka River Watershed	
Hydrologic Soil Groups	**Acres**	**% Cover**	**Acres**	**% Cover**
A	274,178	18%	21,824	6%
B	9,605	1%	2,546	1%
C	939	0.1%	0	0%
D	36,763	2%	57	0%
A/D	730,469	49%	238,021	63%
B/D	227,008	15%	17,537	5%
C/D	149,553	10%	92,909	25%
OTHER	60,452	4%	4,433	1%

Source: NRCS, 2000-2010

2.4.5 Land Use-Specific Runoff Coefficients

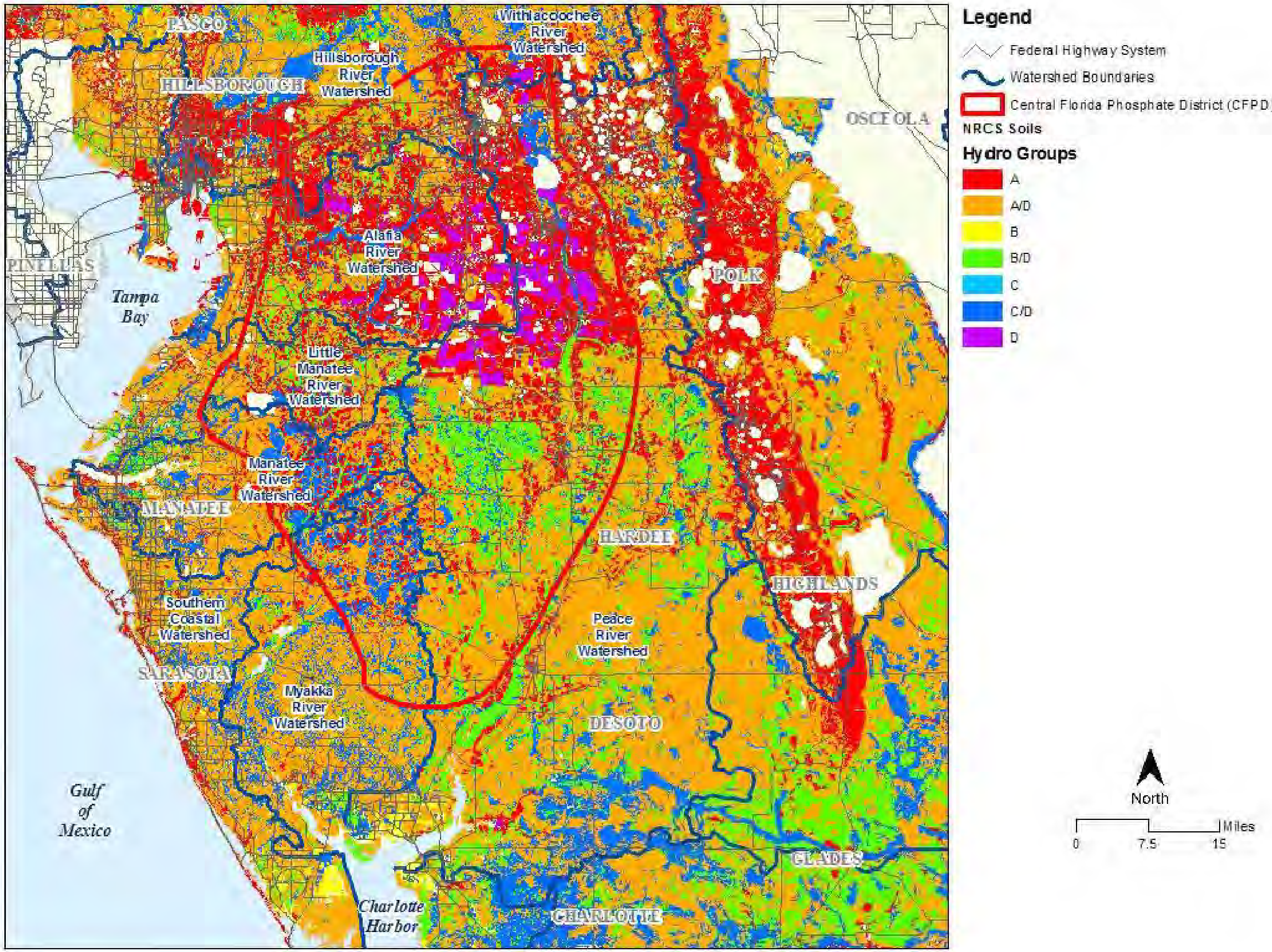
The calibrated land use-specific runoff coefficients developed by Janicki (2010) for the CHNEP pollutant loading evaluations are pertinent in that they defined soil type- and season-specific runoff coefficients for land areas tributary to the CHNEP study area, which includes the AEIS study area. In the CHNEP pollutant loading evaluations, the seasonal land use-specific runoff coefficients shown in Table 3 were calibrated and used to describe runoff from unmetered streams within lands tributary to the Charlotte Harbor Estuary. Their loading estimates relied on the observed USGS gage data for most of the watershed. In the AEIS analysis, the runoff coefficients were used for the entire watershed so future conditions could be addressed in a consistent manner.

2.5 Method Validation Results

2.5.1 Calculations of Flows for Each Watershed

Utilizing the information presented above, flow calculations for each subwatershed in the Peace and Myakka River watersheds were performed using the runoff coefficient method. GIS coverage of land uses for 1990, 1999, and 2009 was overlaid with GIS coverage of soil hydrologic groups to create unique polygons of a known area that have a single land use type and soil hydrologic group. Each polygon was then assigned a runoff coefficient from Table 3. With these data, an area-weighted average runoff coefficient for 1990, 1999, and 2009 was calculated for each subwatershed for both wet and dry seasons. Rainfall and USGS gage flow records from 1985 through 2011 were used to calculate average annual runoff for this period of record. Land use was reassigned every 10 years, so there is a stair-step change to the Cd values. Cd values were adjusted according to changes in land use based on the SWFWMD FLUCCS data for 1990, 1999 and 2009, where 1990 data were applied to 1985 through 1995, 1999 data were applied to 1996 through 2005, and 2009 data were applied to 2006 through 2011. To adjust the AEIS water balance approach to observed flow records, the long-term hydrologic adjustment factor was varied to better represent the predictions of the observed data for each year.

FIGURE 11
Soils Hydrologic Group Map



Source: NRCS, 2000 - 2010

TABLE 3
Land Use-Specific Seasonal Runoff Coefficients for Lands Tributary to Charlotte Harbor Estuary

Land Use	Hydrologic Soil Group	Dry Season Runoff Coefficient	Wet Season Runoff Coefficient
Single Family Residential	A	0.15	0.25
	B	0.18	0.28
	C	0.21	0.31
	D	0.24	0.34
Medium Density Residential	A	0.25	0.35
	B	0.30	0.40
	C	0.35	0.45
	D	0.40	0.50
Multifamily Residential	A	0.35	0.50
	B	0.42	0.57
	C	0.50	0.65
	D	0.58	0.75
Commercial	A	0.70	0.79
	B	0.74	0.83
	C	0.78	0.97
	D	0.82	0.91
Industrial	A	0.65	0.75
	B	0.70	0.80
	C	0.75	0.85
	D	0.80	0.90
Mining	A	0.20	0.20
	B	0.30	0.30
	C	0.40	0.40
	D	0.50	0.50
Institutional, Transportation, Utilities	A	0.40	0.50
	B	0.45	0.55
	C	0.50	0.60
	D	0.55	0.65
Range Lands	A	0.10	0.18
	B	0.14	0.22
	C	0.18	0.26
	D	0.22	0.30

TABLE 3
Land Use-Specific Seasonal Runoff Coefficients for Lands Tributary to Charlotte Harbor Estuary

Land Use	Hydrologic Soil Group	Dry Season Runoff Coefficient	Wet Season Runoff Coefficient
Barren Lands	A	0.45	0.55
	B	0.50	0.60
	C	0.55	0.65
	D	0.60	0.70
Agricultural – Pasture	A	0.10	0.18
	B	0.14	0.22
	C	0.18	0.26
	D	0.22	0.30
Agricultural – Groves	A	0.20	0.26
	B	0.23	0.29
	C	0.26	0.32
	D	0.29	0.33
Agricultural - Feedlots	A	0.35	0.45
	B	0.40	0.50
	C	0.45	0.55
	D	0.50	0.60
Agricultural - Nursery	A	0.20	0.30
	B	0.25	0.35
	C	0.30	0.40
	D	0.35	0.45
Agricultural - Row and Field Crops	A	0.20	0.30
	B	0.25	0.35
	C	0.30	0.40
	D	0.35	0.45
Upland Forests	A	0.10	0.15
	B	0.13	0.18
	C	0.16	0.21
	D	0.19	0.24
Freshwater - Open Water	A	0.80	0.90
	B	0.80	0.90
	C	0.80	0.90
	D	0.80	0.90

TABLE 3
Land Use-Specific Seasonal Runoff Coefficients for Lands Tributary to Charlotte Harbor Estuary

Land Use	Hydrologic Soil Group	Dry Season Runoff Coefficient	Wet Season Runoff Coefficient
Saltwater - Open Water	A	1.00	1.00
	B	1.00	1.00
	C	1.00	1.00
	D	1.00	1.00
Forested Freshwater Wetlands	A	0.50	0.60
	B	0.55	0.65
	C	0.60	0.70
	D	0.65	0.75
Saltwater Wetlands	A	0.95	0.95
	B	0.95	0.95
	C	0.95	0.95
	D	0.95	0.95
Non-Forested Freshwater Wetlands	A	0.45	0.55
	B	0.50	0.60
	C	0.55	0.65
	D	0.60	0.70
Tidal Flats	A	1.00	1.00
	B	1.00	1.00
	C	1.00	1.00
	D	1.00	1.00

Source: Janicki, 2010

The calculated flow results compared well to measured flows for the Horse Creek, Peace River at Arcadia, and upper Myakka River subwatersheds as presented in Figures 12 through 14, respectively. Some of the deviations may be related to tropical storm activity (especially in 2004) or unusual long-term wet conditions (1998). But even considering those years', the variability in the results was not unusual for hydrologic prediction. The long-term adjustment factors used for these subwatersheds are presented in Table 4. The long-term hydrologic adjustment factor decreased with lower rainfall years, which means that the conventional runoff coefficient approach is less accurate for lower rainfall years unless the adjustment factor is varied by annual rainfall too. The adjustment factor approaches the value of 1.0 as rainfall approaches or exceeds average rainfall conditions. Since the pollutant loading equation is usually applied for estimating average conditions, it is generally accurate when assumed to be approximately 0.9. The upper Peace River adjustment factor was found to have a lower value than at the other subwatersheds; this is attributed to the many lakes, Group A soils in the upper Peace River watershed, and active mines that would retain more surface water in dry years. The Horse Creek and upper Myakka River subwatersheds had soils with higher runoff potential and a lower fraction of active mines, so their adjustment factors were similar.

FIGURE 12
Calculated and Measured Flows in the Horse Creek Subwatershed

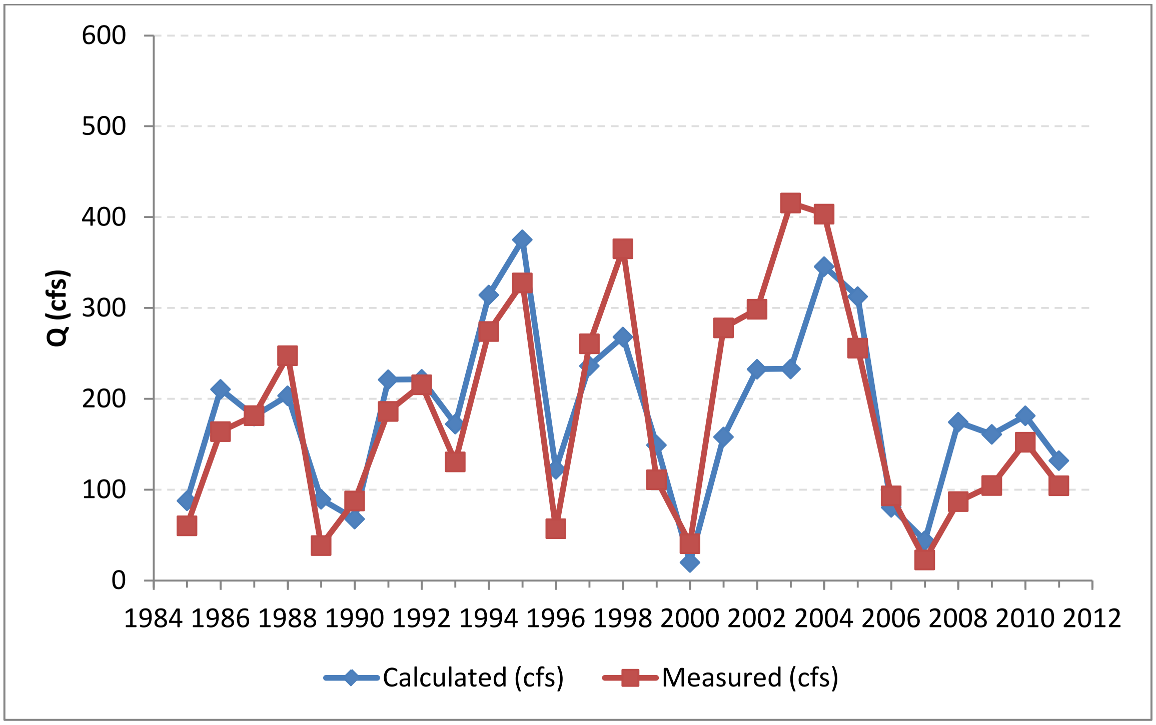


FIGURE 13
Calculated and Measured Flows in the Peace River at Arcadia Subwatershed

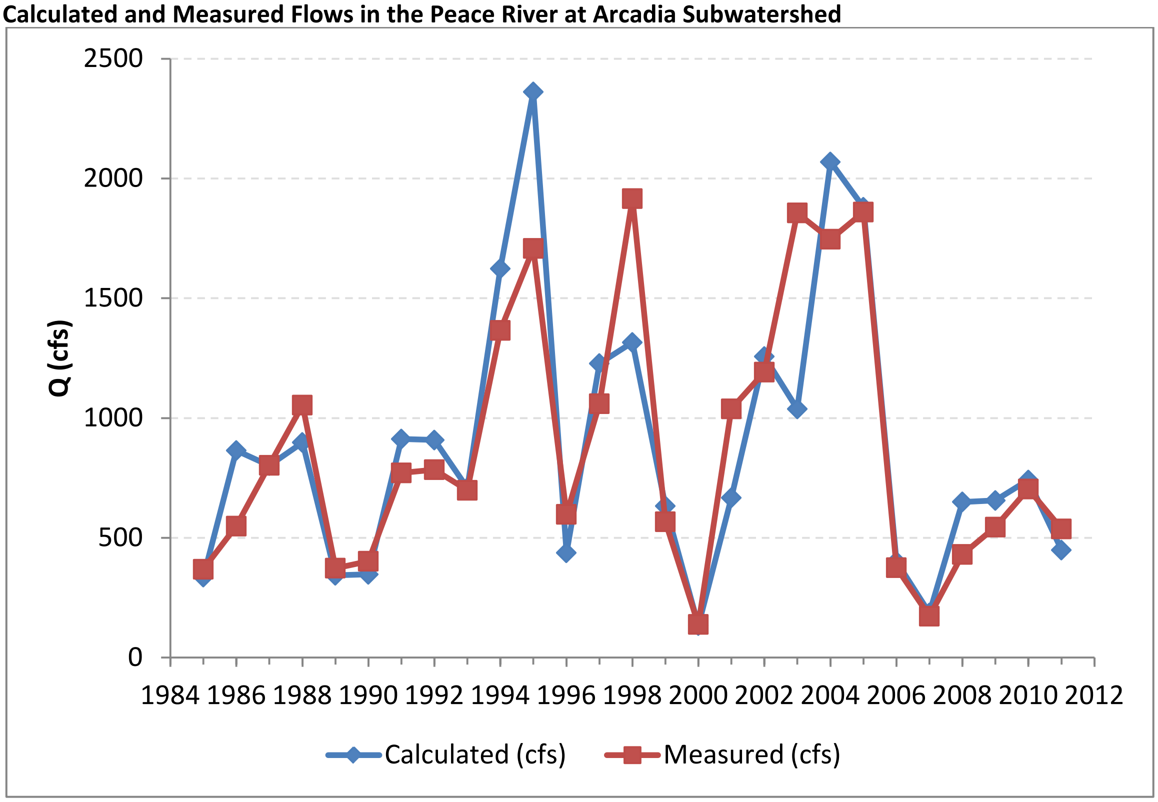
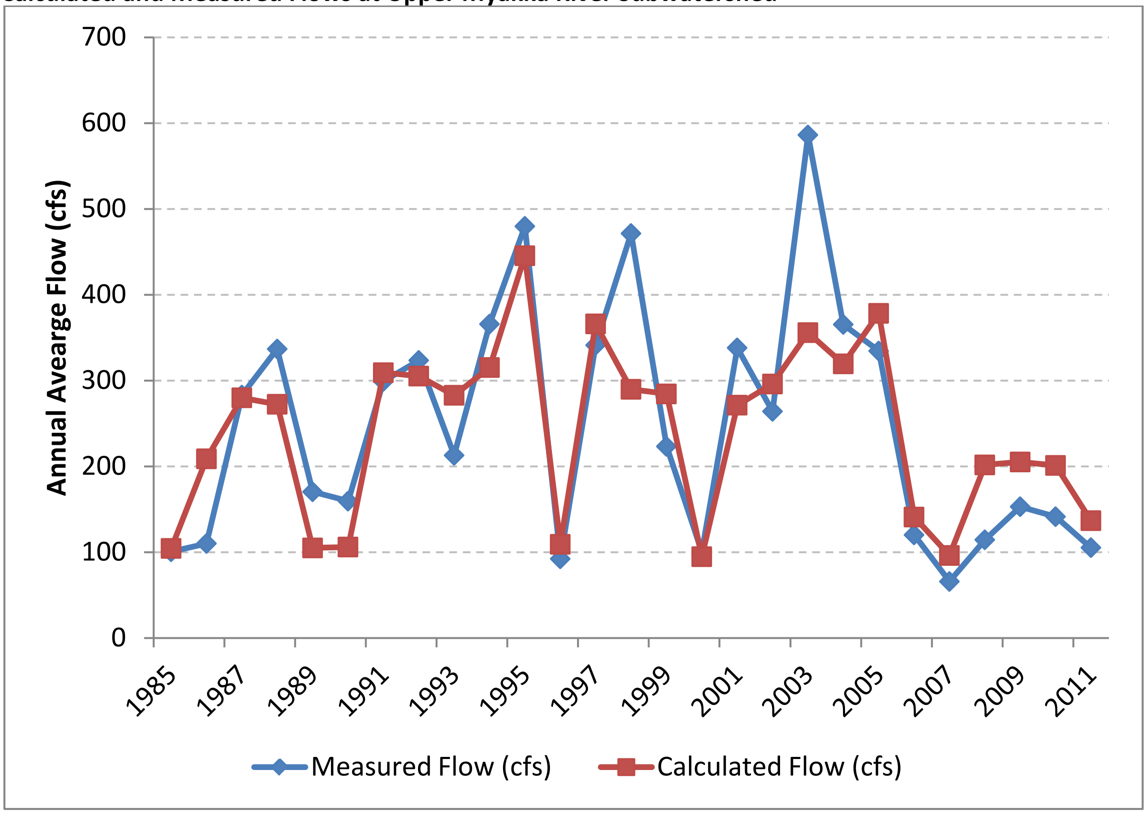


FIGURE 14
Calculated and Measured Flows at Upper Myakka River Subwatershed



(The highest measured flow reading in 2004 [an active hurricane season] at this gage appeared unusual when compared to other days and was perhaps estimated.)

TABLE 4
Long-Term Hydrologic Adjustment Factors (j) Applied to Better Represent the Annual Average USGS Gage Data Using Runoff Coefficients

Rainfall (in)	PR nr Bartow	PR nr Zolfo	PR nr Arcadia	Payne Ck	Charlie Ck	Joshua Ck	Horse Ck	Prairie Ck
30	0.05	0.1	0.1	0.1	0.1	0.3	0.1	0.2
36	0.05	0.2	0.1	0.3	0.2	0.5	0.2	0.2
39	0.1	0.3	0.2	0.4	0.3	0.6	0.3	0.3
40	0.1	0.3	0.2	0.5	0.3	0.6	0.3	0.3
41	0.1	0.3	0.2	0.5	0.3	0.6	0.4	0.3
43	0.1	0.3	0.2	0.6	0.4	0.7	0.4	0.3
44	0.1	0.4	0.2	0.6	0.4	0.7	0.5	0.3
47	0.2	0.4	0.3	0.7	0.5	0.8	0.6	0.4
48	0.2	0.5	0.3	0.7	0.5	0.8	0.6	0.4
49	0.2	0.5	0.3	0.8	0.5	0.8	0.6	0.4
50	0.2	0.5	0.4	0.8	0.5	0.9	0.7	0.4
51	0.3	0.5	0.4	0.9	0.6	0.9	0.7	0.5
52	0.3	0.5	0.4	0.9	0.6	0.9	0.7	0.5

TABLE 4
Long-Term Hydrologic Adjustment Factors (j) Applied to Better Represent the Annual Average USGS Gage Data Using Runoff Coefficients

Rainfall (in)	PR nr Bartow	PR nr Zolfo	PR nr Arcadia	Payne Ck	Charlie Ck	Joshua Ck	Horse Ck	Prairie Ck
53	0.3	0.6	0.4	0.9	0.6	0.9	0.8	0.5
55	0.4	0.6	0.5	1.0	0.7	1.0	0.8	0.5
58	0.5	0.7	0.6	1.1	0.8	1.1	0.9	0.6
59	0.6	0.7	0.6	1.1	0.8	1.1	0.9	0.6
60	0.6	0.7	0.7	1.2	0.8	1.1	1.0	0.7
62	0.7	0.8	0.8	1.3	0.9	1.2	1.0	0.7
65	1.0	0.8	0.9	1.4	1.0	1.3	1.1	0.8

Factors include a unit conversion.
Each column represents the USGS gage near the end of the tributary or river segment.
PR is Peace River; nr is near; and Ck is Creek.

By using the long-term adjustment factor as a calibration factor, the runoff coefficient water balance approach yielded reasonable results when compared to measured flow records. The mean error associated with this approach for estimating annual average flow in the Horse Creek, Peace River at Arcadia, and upper Myakka River subwatersheds for the periods of record analyzed ranged from 5 to 20 percent. Lee et al. (2010) calibrated a detailed MIKE-SHE model of Charlie Creek and reported a mean error of 57 percent for daily runoff estimates at the downstream end of the subwatershed for their 3 years of observed data. However, these modeled errors tend to be smaller when looking at annual totals. This calibration process validated that the runoff coefficient approach was appropriate for quantification of annual and seasonal surface runoff in the future for various land use changes. The adjustment factor was estimated for every subwatershed in the Peace and Myakka River watersheds where USGS gage data were available. For the ungaged areas near the southern end of the watersheds, the adjustment factor values in nearby subwatersheds were used.

2.5.2 Estimating Excess Precipitation at Active Mines

The runoff coefficient approach for estimating long-term runoff assumed constant values for mined land, given a soil type (Janicki, 2010). However, there is more information available from the applications that can be used to determine how the runoff potential varies throughout the life of each of the Applicants' Preferred Alternatives. For these mines, the following procedure was used to estimate runoff during active mining for the 50 percent capture case for comparison to the runoff coefficient method. This same procedure was used by the AEIS groundwater modeling team to estimate changes in recharge for the groundwater model. In this way, the two analyses are consistent in how the surface water on the Applicants' Preferred Alternatives is hydrologically accounted for.

The ditch and berm system collects rainfall and reuses it inside the active mines, as described above. One purpose of this system is to provide water for settling in the CSAs, which are essentially large settling ponds. The water stored onsite is subject to evaporation from open water or ET from the soil and cover. The open water evaporation rate is higher than ET rates. To estimate the relative amount of water available to storage in a year, a simple water balance was conducted to predict the excess precipitation (Excess P) on the active mine site as follows:

$$\text{Excess P} = \text{Annual P} - \text{ET} - \text{Net Recharge into SAS} - \text{River Cell Discharge}$$

Precipitation rates are about 50 in/yr and 53 in/yr in the Peace and Myakka River watersheds, respectively. The literature review indicated that the general mixed landscape has an average ET rate of about 36.9 in/yr. The SWFWMD groundwater modeling conducted to simulate the effect of deep aquifer pumping was utilized to determine the Net Recharge (in/yr) and the River Cell Discharge (in/yr). These two parameters were taken from the existing conditions simulation (the 2010 scenario, which is the same as unmined conditions for these alternatives) and only for the model cells where the Applicants' Preferred Alternatives mine sites are located. The Net Recharge value was part of the input developed for the region by the SWFWMD. This represents the amount of rainfall reaching the SAS. In the active mines, this water is subject to being captured and used onsite. The River Cell Discharge is the amount of water that the SWFWMD model estimates to seep out of the groundwater domain. This drainage volume typically becomes part of the baseflow that maintains the long-duration low flows during the year. Preliminary groundwater modeling of future conditions indicated that the mines' River Cell Discharge did not change appreciably over the study period, so a constant existing conditions value was used for future conditions in estimating potential Excess P.

The mine plans submitted in the applications for the four Applicants' Preferred mines were used to determine how much land was captured. The relative proportion of active mining and CSAs, along with corresponding changes in ET rates, was used to calculate the Excess P for the active and unmined land for each year of the plan. An ET rate of 50 in/yr was used for CSA areas and 20 in/yr for actively mines areas. The Excess P on the mine would then be retained (for onsite reuse) or discharged through an NPDES outfall depending on the available storage in the active mine. Table 5 provides a summary of the range of Excess P values estimated for the Applicants' Preferred Alternatives assuming 50 percent is captured and used onsite. The Excess P values of the water not retained is the surface water delivery potential from each mine for 2020, 2030, 2040, 2050, and 2060 (see Table 6). This alternative computation method provided results within 1 cfs of the runoff coefficient estimates for the peak year reductions for average annual results. Therefore, these estimates provide further validation that the runoff coefficients would provide results of sufficient accuracy for the regional surface water flow estimates.

TABLE 5

Estimated Range of Excess Precipitation of the Applicants' Preferred Alternatives

	South Pasture Mine Extension			Ona			Desoto			Wingate East		
Hydrologic Component	**Avg. (in/yr)**	**Min. (in/yr)**	**Max. (in/yr)**	**Avg. (in/yr)**	**Min (in/yr).**	**Max. (in/yr)**	**Avg. (in/yr)**	**Min. (in/yr)**	**Max. (in/yr)**	**Avg. (in/yr)**	**Min. (in/yr)**	**Max. (in/yr)**
Precipitation	50	--	--	50	--	--	50	--	--	53	--	--
Mined Avg. ET	35.4	28.3	40.2	36.0	32.5	39.6	33.3	29.8	38.1	35.9	33.3	38.7
Groundwater Model River Flux	-0.69	--	--	-2.7	--	--	-3.6	--	--	-0.01	--	--
Unmined Excess Precipitation	6.7	--	--	8.9	--	--	9.7	--	--	14.3	--	--
Mine Excess Precipitation	5.4	3.5	6.7	7.0	5.4	8.8	7.0	5.7	9.5	10.6	9.1	13.6

ET and Excess P varied primarily as a result of the amount of land being mined or utilized by mining at any given year during the life of the mine. "—" means that this value did not vary over the mine life in the evaluation.

TABLE 6
Estimated Excess Precipitation Discharged from Each Applicant Preferred Alternative in the Future with 50 Percent Captured Onsite

Year	South Pasture Mine Extension (in/yr)	Ona (in/yr)	Desoto (in/yr)	Wingate East (in/yr)
2020	6.4	8.8	9.7	12.8
2030	3.6	7.2	6.5	10.0
2040	6.3	5.8	7.4	10.1
2050	6.7	6.2	9.7	10.4
2060	6.7	8.6	9.7	14.3

2.6 Key Assumptions Related to Mining

Several key assumptions were applied during the surface water evaluations. One key assumption was that the current practice of using isolation berms and ditches to retain water and to hydrate surrounding surficial groundwater (i.e., ditch and berm system) will continue at the Applicants' Preferred Alternatives. This assumption is based on the Applicants' plans as presented to the USACE. Control of runoff from mine areas is required under industrial wastewater operations permits issued by the FDEP, and the ditch and berm systems are the infrastructure features used to ensure stormwater capture and to control offsite runoff through outfall structures permitted under the NPDES.

Large areas that are to be mined (mine blocks) are surrounded by ditches and berms before active mining operations and the ditches support surface water management for the active mine areas until those lands are reclaimed and subsequently released from the regulated areas. Each mine plan shows how the active mining would proceed across the mine in mine blocks, and what blocks would be mined during discrete periods of time.

The sequencing of ditch and berm installations around mine blocks, and subsequent reclamation and release schedules, define the timing and duration when stormwater from a particular mine block is re-routed through the mine's internal water system for onsite use or discharge through an NPDES outfall. The key point is that the acreage included in a mine's "capture area" varies over time, with the theoretical capture area curve following a somewhat parabolic shape over the course of a given mine's life cycle. In short, the amount of a mine's total footprint that is removed from contribution to downstream water deliveries is always less than the total footprint, and the relative influence on downstream water deliveries is variable rather than static. Understanding the effects of a given mine on downstream water deliveries thus requires assessment of this dynamic relationship over the full life cycle of the mine.

A second key assumption was that current Florida regulations on phosphate mining and mine reclamation will continue in the future essentially as they currently exist. There are strict schedule limits that require reclamation "as you go." During the life cycle of the mines, portions of the active mine blocks that are finished would be reclaimed and released within a few years. Release of these reclaimed areas cannot occur until they are shown to be reclaimed according to the mine reclamation plan. All four of the Applicants' Preferred Alternatives would use the overburden and sands produced by the beneficiation process to fill mine cuts during reclamation. Clays would be deposited into CSAs. Reclamation of CSAs once they are full requires a longer timeline because of the need for material settling and consolidation to levels allowing grading and re-vegetation. As a result of the sequencing of mine blocks over the course of a given mine's life cycle, and the complex relationships between reclamation schedules and periods, the amount of the mine's footprint which continues to contribute surface water to downstream water bodies varies over time. The variation in "capture area" during the life of the mines is addressed in greater detail in Section 4 of this TM.

For the runoff evaluations for the four Applicants' Preferred Alternatives, it was further assumed that 50 to 100 percent of the stormwater on the actively mined areas was captured and incorporated into the mine recirculation system's waters. In actual operations, there are times when the recirculation system's capacity to store water is exceeded, resulting in offsite discharges to surface waters through the outfalls permitted under the NPDES elements of the applicable industrial wastewater permits issued to mines by the FDEP. The Applicants provided computations indicating that about 35 percent of the potential runoff is captured, on average, at a mine using the typical dragline method[5]. For Wingate East, where a hydraulic dredge is used for most of its mining, there is less available onsite water storage so there is little capture of stormwater. To be conservatively high in the reduction of offsite runoff from an active mine area, a runoff capture of 50 percent was assumed to be closer to a normal surface water reduction. To be even more conservative in times of drought, it was further assumed that all of runoff would be captured at times (100 percent capture). For this case, the capture area analyses applied in the AEIS ignore the fact that at times some of the water captured in the active mine areas is still delivered downstream, at least through seepage from the ditch and berm system. This 100 percent capture was considered a method to conservatively estimate the highest (i.e., bounding) worst-case impact of the Applicants' Preferred mines on downstream water contributions. When discussing the results, a range of potential effects are presented, the 50 percent and 100 percent cases, which are both conservative for normal and droughty conditions, respectively.

The No Action Alternative impact on surface water is the expected runoff in the future with no additional mining in wetlands or streams, but with existing mines being finished and reclaimed. However, how much additional mining that would actually occur is uncertain if the Applicants' Preferred Alternatives were not executed according to the plans submitted in the applications. To quantify the No Action Alternative future flows, no new mining in the Applicants' Preferred Alternatives or offsite alternatives was assumed. This would provide the maximum estimated differences between flow rates from the No Action (without mining) and alternatives with mining. When this TM refers to results without mining, this is the No Action Alternative. In practice, if future mining were to occur on uplands, then the degree of the impacts to surface water would be between the No Action Alternative without mining and the specific alternative evaluated.

Flow computations were performed using spreadsheets, and computations were not rounded until the final tables were produced. Therefore, there may be some small nuances related to rounding the percentages and flows listed in the tables. Additional assumptions related to how to predict the surface water delivery from the mined lands are discussed further in the following subsections.

2.6.1 Effect of Soil Changes to Runoff Coefficients at Mines after Mining is Completed

The runoff coefficient values are defined as a function of soils and land use. The surface water delivery can be described as the direct runoff during and immediately after a rainfall event plus the rainfall that is infiltrated and seeps out to the streams later. Different authors use varying terms to describe the components of the water balance in the near-surface environment. For natural systems on sloped land, there is typically a significant volume of rainfall that infiltrates but re-surfaces at lower elevations, delayed but relatively soon after a storm (from hours to days depending on the slope and geology). As noted above, this component is sometimes called interflow. While not necessarily computed as direct runoff, this delayed flow is part of the record of surface water delivery as monitored at downstream USGS gages. Low flow conditions are often called baseflow, but Lewelling (1997) tended to use the term baseflow to represent only the groundwater derived from lower aquifers. The delayed seepage of rainfall stored in the SAS into streams is also called groundwater discharge (Lewelling, 1997) or groundwater outflow (BCI, 2010b [MIKE SHE simulation]). Regardless of the nomenclature, the runoff coefficients represent a sum of the total runoff over time, including both the direct and rapid runoff and the delayed groundwater component. By utilizing observed gage runoff data to calibrate and adjust the coefficients, they inherently include all components of the surface water delivery from a watershed.

The phosphatic mineral mined (i.e., a combination of rock, sand, and clay that is typically referred to as the *matrix*) is about 40 to 70 feet deep in the Applicants' Preferred mine sites. The soils that overlay the matrix are

[5] Garlanger, 2011, submitted as comments on the DAEIS. These data were also confirmed in the Water Use Permit applications.

called the overburden, which consists primarily of sandy soil that becomes more clayey and phosphatic with depth (Duerr and Enos, 1991; Lewelling, 1997). Generally, the matrix is near the bottom of the surficial aquifer, which ranges in thickness from 25 to 100 feet in Hardee and DeSoto Counties (Duerr and Enos, 1991). The intermediate Florida aquifer system (FAS) consists of three primary layers, with the top and bottom consisting of clayey layers that restrict groundwater flow between the aquifers (i.e., surficial, intermediate, and Floridan) (Duerr and Enos, 1991). These restrictive layers affect the movement of groundwater that is infiltrated into deeper zones (also called deep recharge). The net recharge under the Applicants' Preferred Alternatives is expected to have similar deep recharge for both pre- and post-mining because these deeper restrictive layers of soil would not be altered.

Consequently, the SAS is the region of most interest concerning soil impacts because it would be dramatically altered during the mining process. The surface water runoff would be affected by the nature of the top layer of soil (A horizon) and the position of the groundwater table during the year. The amount of rainfall that can be infiltrated would be reduced during high water table conditions and stored groundwater could discharge more readily when the water table is closer to the surface. The NRCS assigns mixed hydrologic soil group designations (e.g., A/D) to represent the runoff potential of poorly drained conditions (including high water table). This high water table condition, which varies during the year, is primarily why the runoff coefficients were divided into dry and wet season components. The runoff coefficient method used the different seasonal values to account for temporal differences. To provide an illustrative example, the soils at the Desoto Mine site were used to estimate the effect of mining on the predicted surface water runoff by the runoff coefficient method.

The Desoto Mine site encompasses about 18,500 acres (based on the GIS shape file provided by the Applicant), of which 18,282 acres would be actively mined during the life of the mine (according to the mine plan). Using the hydrologic soil group and land use for the existing Desoto Mine footprint, the predicted pre-mining runoff coefficients from this area are 0.27, 0.36, and 0.30 for the dry, wet, and annual values, respectively (as derived from the analysis in Section 5). The ratio between wet and dry season values is 1.35, or 35 percent higher runoff potential during the wet season. However, the annual value is averaged based on the typical amount of rainfall that falls in each season (1/3 during dry season and 2/3 during wet season).

The way that the phosphate industry manages soils and reclaims land has changed over the years. When an area is mined (a mine block), the topsoil and other soils that may be useful in reclamation, like muck, are stripped and used elsewhere on the mine, or stored. The next layers of soil are collectively called the overburden, which is placed in an adjacent cut or stored for later use. The bulk of the fill in the open cuts is overburden, which becomes more homogenous through the handling process. The matrix is separated at the beneficiation plant, clayey material is sent to CSAs for settling, and the sand tailings are used to help restore the topography on top of the overburden and into gaps formed by irregularities in the surface. In some cases, overburden is mixed in the sand tailings to help provide workability and water storage capacity for future plantings. CF Industries has recently been using a sand/clay mixture for its backfilling and reclamation but would not use this method at the South Pasture Mine Extension. The conventional clay disposal techniques (CSAs) are used now to reduce the footprint of the CSAs and to increase the sandy soil tailings. Additionally, improved methods of operating the CSAs allow them to be reclaimed more quickly than in previous years. However, as the CSAs settle, there are areas that remain very wet or even open water. While the Applicants do not receive mitigation credit for these wet areas (approximately 20 percent of the CSAs), these areas still affect the runoff potential from the post-reclamation sites. To summarize, the post-reclamation mines would consist of sandy soils and low-permeability CSAs that have a substantial fraction of wet area. Topsoil would be utilized to improve the surface for plantings, and mucky soils would be spread on top of areas designated to be reclaimed as wetlands.

The post-reclamation plans are specified in the Applicants' conceptual mine plans, which become part of their permit. These plans would be regularly updated during the life of the mine. For the Desoto Mine, the conceptual mine plan was used to identify the areas to be mined and CSAs, as shown in Table 7. While the footprints may vary somewhat among the Applicants' Preferred Alternatives because of differing quantities of clay, Desoto represents a new mine without any sharing of existing CSAs, which is why it was chosen for this example (i.e., a stand-alone mine). The counties typically require that the mines be restored to the general land use that existed prior to mining (agricultural) to the extent practicable. The runoff potential of the post-reclamation mined landscape was evaluated by assuming that the average runoff potential of the A soils pre-mining represented a mixed land use similar to the sand tailings fill areas. The CSAs are normally used as improved pasture (D soils for clayey material) and about 20 percent of them are wet or open water. The appropriate runoff coefficients are shown in Table 3, and they were applied to the areas (also listed) to develop new runoff coefficients for the post-mine. As shown in Table 7, the difference between the predicted pre- and post-mine runoff coefficient is negligible.

Florida rules require that the restoration of the mines meet their reclamation plan objectives. The landscape is topographically graded to contours similar to pre-mining, and the soils must be utilized in a manner to support their use (uplands, forested wetlands, emergent wetlands, etc.). Once the reclaimed mine is released, the outfalls are removed and there is no practical way to monitor flows onsite. Therefore, it is presumed based on mine application information that the long-term runoff is similar to pre-mined conditions over an area-weighted basis. Also, a runoff coefficient of 0.3 (from Table 7) times the adjustment factor of 0.7, which was used in the long-term runoff equation, is 0.21 (Section 2.3) and this is very similar to the percent of rainfall monitored as surface water delivery at the Horse Creek USGS flow gage near Arcadia (22.4 percent; Schreuder, 2006).

TABLE 7
Example Change in Surface Water Runoff from Desoto Mine using Runoff Coefficients

Areas to be Used at Desoto Mine (per Application)	**(ac)**		
Total Area	18,465	= Total Desoto footprint (area in GIS)	
Area to be Mined in total	18,282	from Desoto Mine plan (mine blocks)	
Area not to be Mined (wetlands/urban)	183	Difference from mine plan and GIS footprint	
Total Area to be reclaimed, but not CSAs	13,990	= Non-CSA post-reclamation, A Soils	
Areas of CSAs from Desoto Mine Plan (23.2%)	4,292	= CSAs, D Soils	
Runoff Coefficients to use Post-Mining:	**Dry**	**Wet**	**Assumptions**
Mined Area; Avg. of Pre-Mined A Soils Cd	0.25	0.34	Conservatively low runoff for post-mining reclaimed soils
Non-Mined Area; Avg. of Pre-Mined D Soils Cd	0.65	0.75	Assumed mostly roads, drainage, and ditch system
Open-Water/Freshwater Marsh in CSAs, Avg. Cd	0.70	0.80	About 20% of post-mined CSA becomes either swamp or open water
Reclaimed CSAs, D Soils Pasture Cd	0.22	0.30	Post-reclamation CSA typical land use
Results	**Dry**	**Wet**	**Annual**
Post-Mining Average Cd (area weighted)	0.267	0.358	0.297
Pre-Mining Average Cd	0.267	0.361	0.299

While detailed hydrologic modeling of the water balance is not required for the 404 permit application, CF Industries provided an analysis for the South Pasture Mine Extension that they submitted to the FDEP for the ERP application. The MIKE SHE model was utilized to predict the detailed water balance at South Pasture and South Pasture Mine Extension before and after mining (also known as pre- and post-mining) at a small enough grid size (250 x 250 meters) to capture the differences in the landscape (soils, topography, and land use). Table 8 provides a summary of their water balance results expressed as an average of the annual averages over a 15-year simulation period (i.e., using rainfall from 1995 to 2010; BCI, 2010b). This table shows that more water is expected to be retained in the soil or in surface storage and that, in turn, provides more water for ET loss. Surface water delivery as estimated from this analysis is actually somewhat lower, but there is more water captured in the groundwater because of improved wetland capture by the elimination of farm ditches, which is a positive restoration goal. Even with the extra water in the ground, the deep recharge to the intermediate FAS remains similar (about 9 percent more recharge). The net flows across the model boundary in both surface and groundwater are close to each other (pre-mining 13.2 in/yr versus post-mining 12.2 in/yr). The pre-mining total of the simulated overland flow, surface boundary outflow, and baseflow is 10.7 in/yr, similar to the monitored flow at the Horse Creek USGS gage near Arcadia (10.7 in/yr; Schreuder, 2006).

TABLE 8
Simulated Pre- and Post-Mining Water Balance at the South Pasture Mine Extension

Water Balance	Pre-Mining Avg. (in/yr)	Post-Mining Avg. (in/yr)	Difference (Post-Pre)
Rainfall	50.65	50.65	0.00
ET	37.85	39.16	1.31
Overland Flow	10.17	9.09	-1.08
Baseflow	0.26	-0.03	-0.29
Surface Boundary Outflow	0.25	-0.09	-0.33
Groundwater Boundary Outflow	2.49	3.07	0.58
Overland Storage Change	-0.09	-0.15	-0.06
Saturated Zone Storage Change	-0.56	-0.44	0.12
Unsaturated Zone Storage Change	0.29	0.04	-0.26
Error	-0.01	0.01	
Deep Recharge to Intermediate FAS	2.41	2.62	0.21

Source: Tables IMR-11 and IMR-12; BCI, 2010b
FAS is the Floridan aquifer system
Simulation period 1995 to 2010

The South Pasture mine would use the clay/sand mixture to reclaim land, while the South Pasture Mine Extension would use the conventional sand tailing method to reclaim land. Lewelling and Wylie (1993) evaluated the hydrology and water quality from unmined and reclaimed lands that utilized these two different reclamation practices. The hydrologic response (and water quality) from the conventional sand tailings reclaimed mines were found to be similar to those of the unmined lands. The land reclaimed utilizing a sand/clay mix had somewhat reduced surface runoff attributed to surface storage on a recently reclaimed CSA but more rapid responses from clayey areas that are well drained; and a more gradual response to water table recharge in the heavier reclaimed soils (Lewelling and Wylie, 1993).

In summary, these results indicate that the modified landscape does not increase runoff on average because of the CSAs and the deeper recharge over the mine footprint remains similar. While one approach indicates that the long-term average delivery of surface water from reclaimed mines should be similar to pre-mining conditions (runoff coefficients), the computer simulations indicate that the immediate surface water delivery may be somewhat lower (about 10 percent on a long-term average). The net flow across the model boundary as estimated in the model is similar in terms of in/yr between pre- and post-mining conditions at the South Pasture Mine Extension (less than a 1-in/yr difference, about a 10 percent change). Retaining more water onsite is typically considered a positive outcome for the reclamation of farmed areas. Therefore, the net water balances between the pre- and post-mining conditions for the Applicants' Preferred Alternatives are considered to be similar and the differences small. The runoff coefficient method was considered adequate to apply to the reclaimed mine lands based on the available literature.

2.6.2 Post-Reclamation Land Use

Often the local zoning requirements or county-level plans for future land uses influence the post-mining land use (e.g., agricultural, water features, etc.); however, on a large-scale average, most of these lands would be used for agricultural purposes after mining.

For the purposes of analysis, after land is mined, reclaimed, and released, the land use type changes from mining to a combination of pasture, row crop, forested wetland, and non-forested wetland at a predetermined rate based on past reclamation practices. For this evaluation, it is assumed that 46 percent of the reclaimed mined land is reclaimed to pasture, 42 percent to row crop, 5 percent to forested wetlands, and 7 percent to non-forested wetlands. This change was applied to both the existing mined land and the Applicants’ Preferred Alternative.

3.0 Land Use Projections

The AEIS evaluations were designed to compare the predicted surface water delivery with each of the Applicants’ Preferred mines and offsite alternatives in operation to the current flows and to the No Action Alternative (No Action was defined in Section 2 as to assume no mining on the alternative sites). The periods of new mine operations would extend through the life of the alternative or until approximately 2060, the 50-year time period of the AEIS. Therefore, to have reasonable No Action Alternative results to compare against, a means of predicting the effects of future land use changes (other than for phosphate mining) on subwatershed discharges to downstream reaches was required. Such changes in land use over time would be anticipated to modify the existing levels of discharge from a given watershed, with the presumption being that increased urbanization over time would cause a gradual increase in net runoff rates. To account for this change in the existing discharges from the affected subwatersheds, future land use projections through 2060 were needed. Agency projections of land uses this far into the future was not available. Therefore, projections of land use were developed to support this AEIS analysis.

Projections of future land use changes were developed primarily based on the rate of change observed in the SWFWMD FLUCCS data since 1990 for both the No Action Alternative and with the Applicants’ Preferred mines and the offsite alternatives. Land use projections through 2060 were developed in 10-year increments (2020, 2030, 2040, 2050, and 2060). Land use areas for 1990, 1999, and 2009 reflect actual land use from the corresponding SWFWMD GIS database, and land use areas for 2020, 2030, 2040, 2050 and 2060 are projections. The predictions of mining land use are based on existing, Applicants’ Preferred, and most likely development of offsite alternatives, as currently known. For the No Action Alternative, the mine plans of the existing mines were assessed and used to alter their future land use. After the mine is reclaimed and released according to the plan, the land use would presumably change to pasture, row crop, forested wetlands, and non-forested wetlands, as described in Section 2.6.3 above. As for the other land use categories, they represent extrapolations of land use change based on previous trends.

In general, land use changes expected in the three subwatersheds where mining would occur through 2060 include increases in urban land uses and decreases in agricultural land uses. Relatively little change was predicted in land use associated with wetlands based on the historical trends from 1990 through 2009. The projected land use changes were adjusted slightly to ensure that the sum of acreages within the area of interest remained consistent. These projections were used to assess temporal changes in runoff characteristics within these subwatersheds’ No Action Alternative and under the influence of the Applicants’ Preferred Alternatives and offsite alternatives (with-mining). Figures 15 and 16 present land use projections for the Horse Creek subwatershed for the No Action Alternative and for conditions with the Applicants’ Preferred Alternatives and Pioneer Tract Alternative, respectively.

The Horse Creek subwatershed would be the most impacted by the Applicants’ Preferred and offsite alternative mines in terms of percent of land mined. In general, the main differences between the No Action Alternative (no mining) scenario and the with-mining scenarios are a shift in the mining land use (primarily pasture lands and mining) in the future. Figures 17 and 18 present land use projections for the Peace River at Arcadia subwatershed for the No Action Alternative and for conditions with the Applicants' Preferred and Pioneer Tract Alternatives, respectively.

The Peace River at Arcadia subwatershed would experience less mining in terms of area with the Applicants' Preferred and offsite alternatives than it has in the past and with current mines. In terms of percent of the area being mined, the mining land use is relatively small when compared to other predominant land uses. Figures 19 and 20 present land use projections for the upper Myakka River subwatershed for the No Action Alternative and for conditions with the Wingate East and Pine Level/Keys Tract Alternatives, respectively.

FIGURE 15
Land Use Projections for Horse Creek Subwatershed for No Action Alternative through 2060

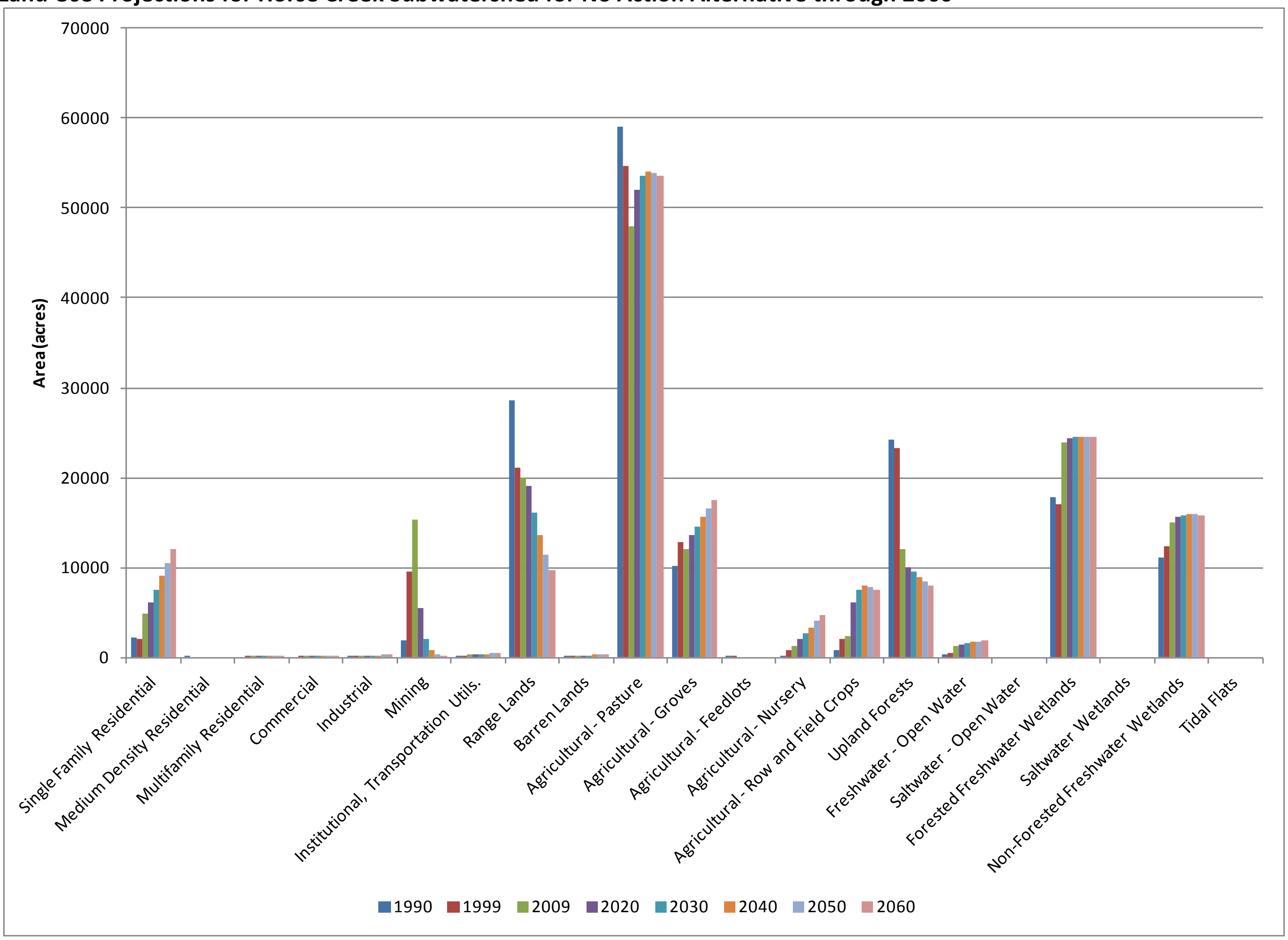


FIGURE 16
Land Use Projections With-Mining for Horse Creek Subwatershed through 2060 (includes Pioneer offsite alternative)

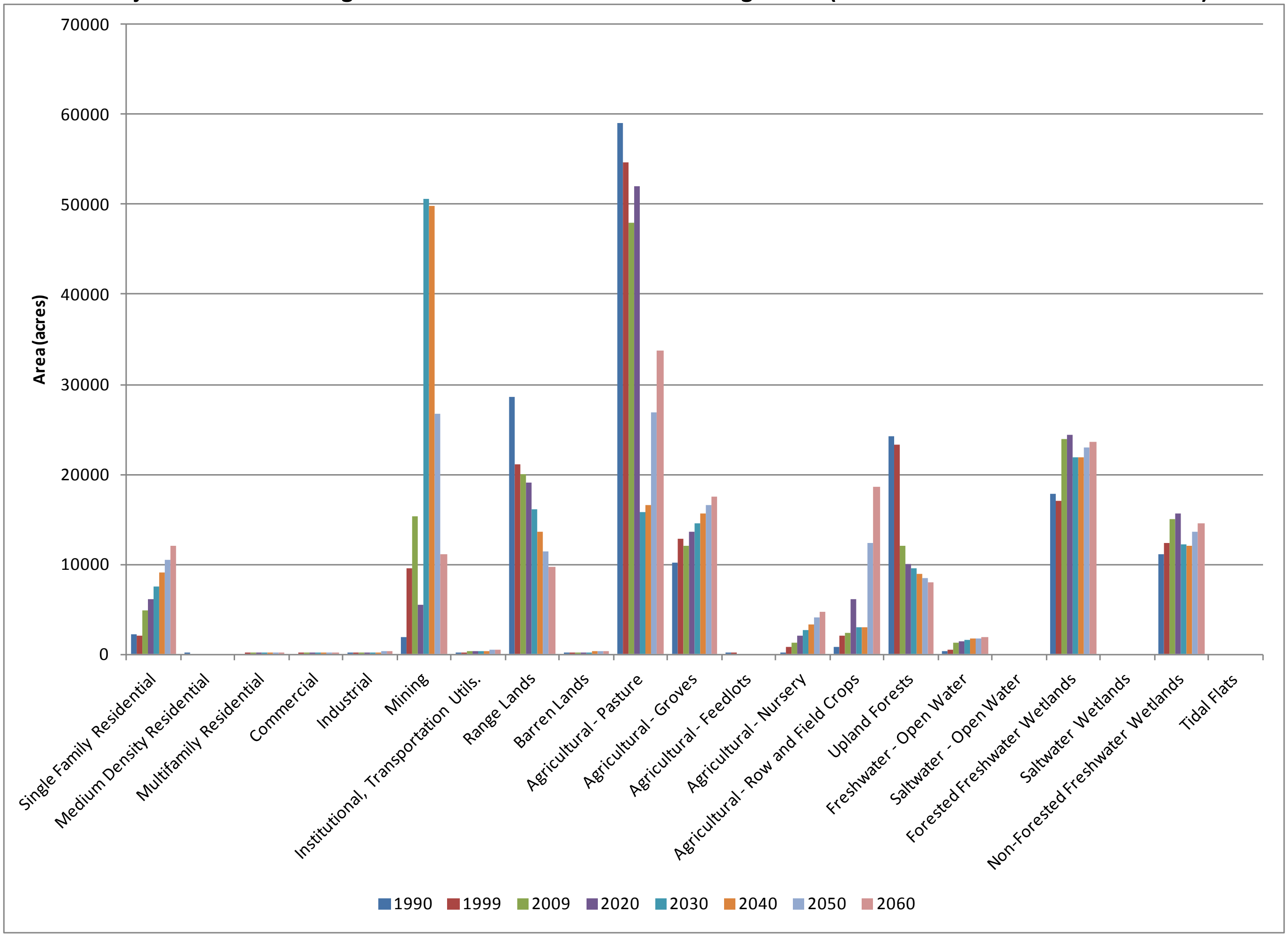


FIGURE 17
Land Use Projections for Peace River at Arcadia Subwatershed for No Action Conditions through 2060

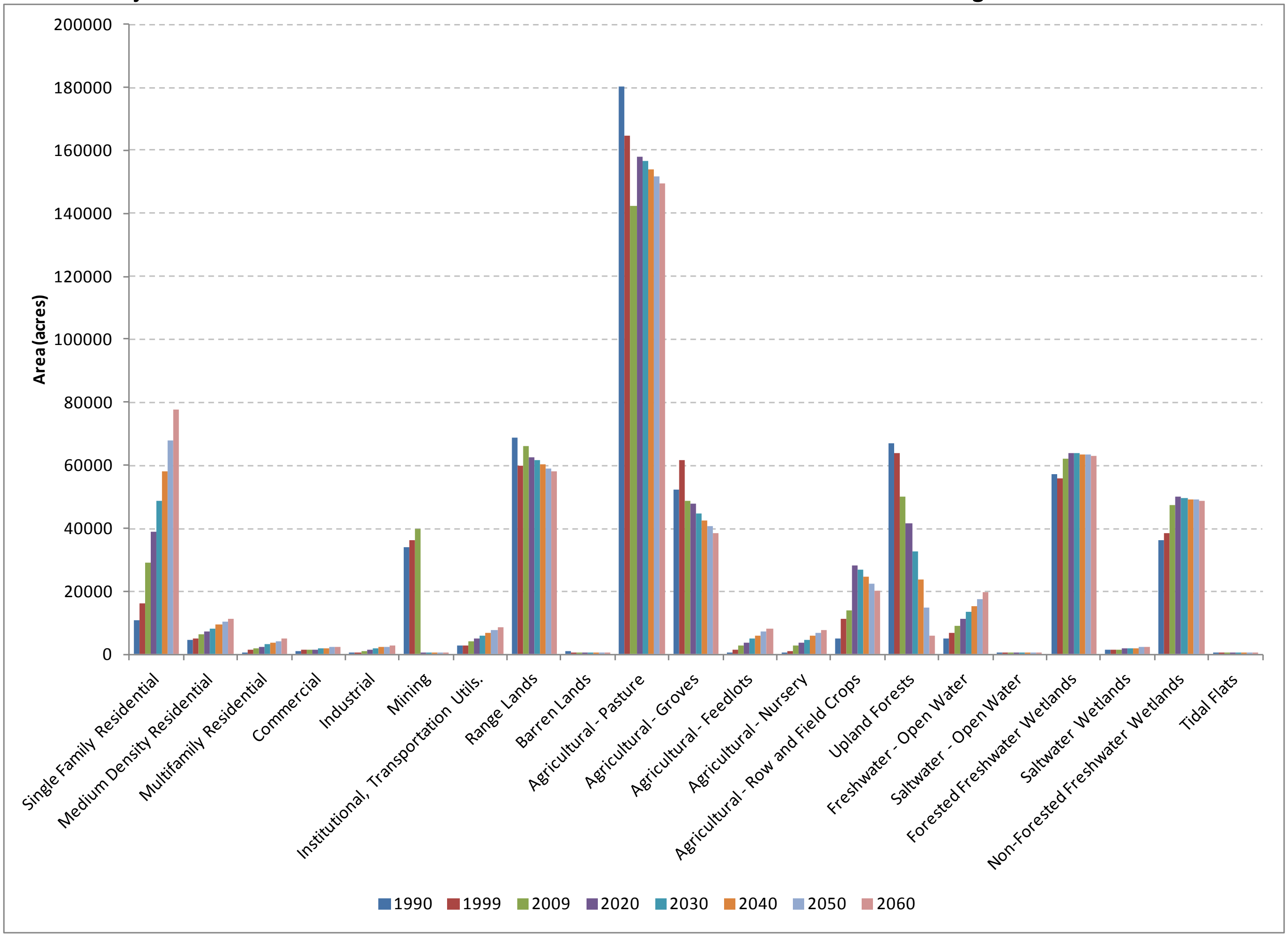


FIGURE 18

Land Use Projections With-Mining for Peace River at Arcadia Subwatershed through 2060 (includes Pioneer offsite alternative)

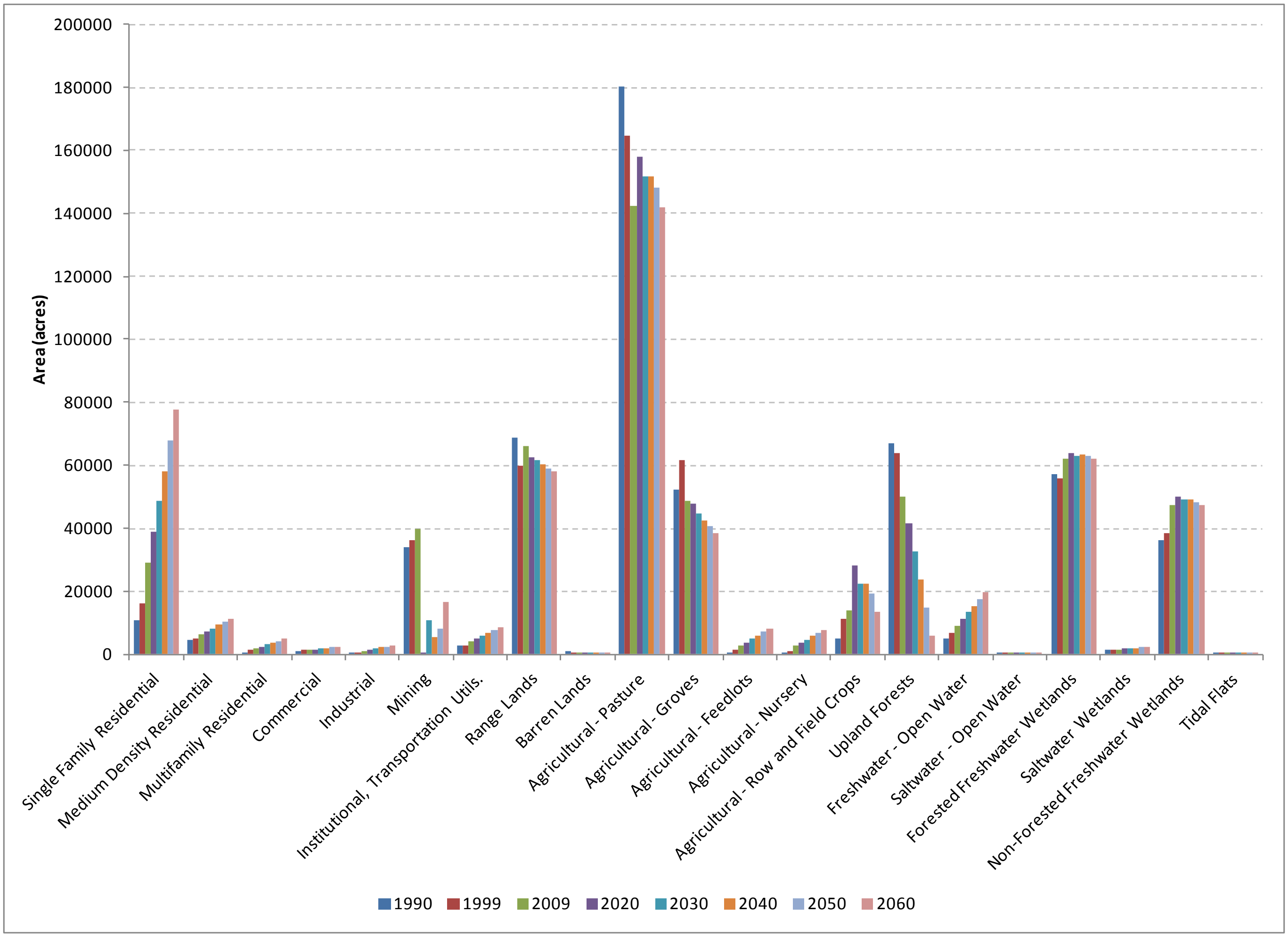


FIGURE 19
Land Use Projections for Upper Myakka River Subwatershed for No Action Conditions through 2060

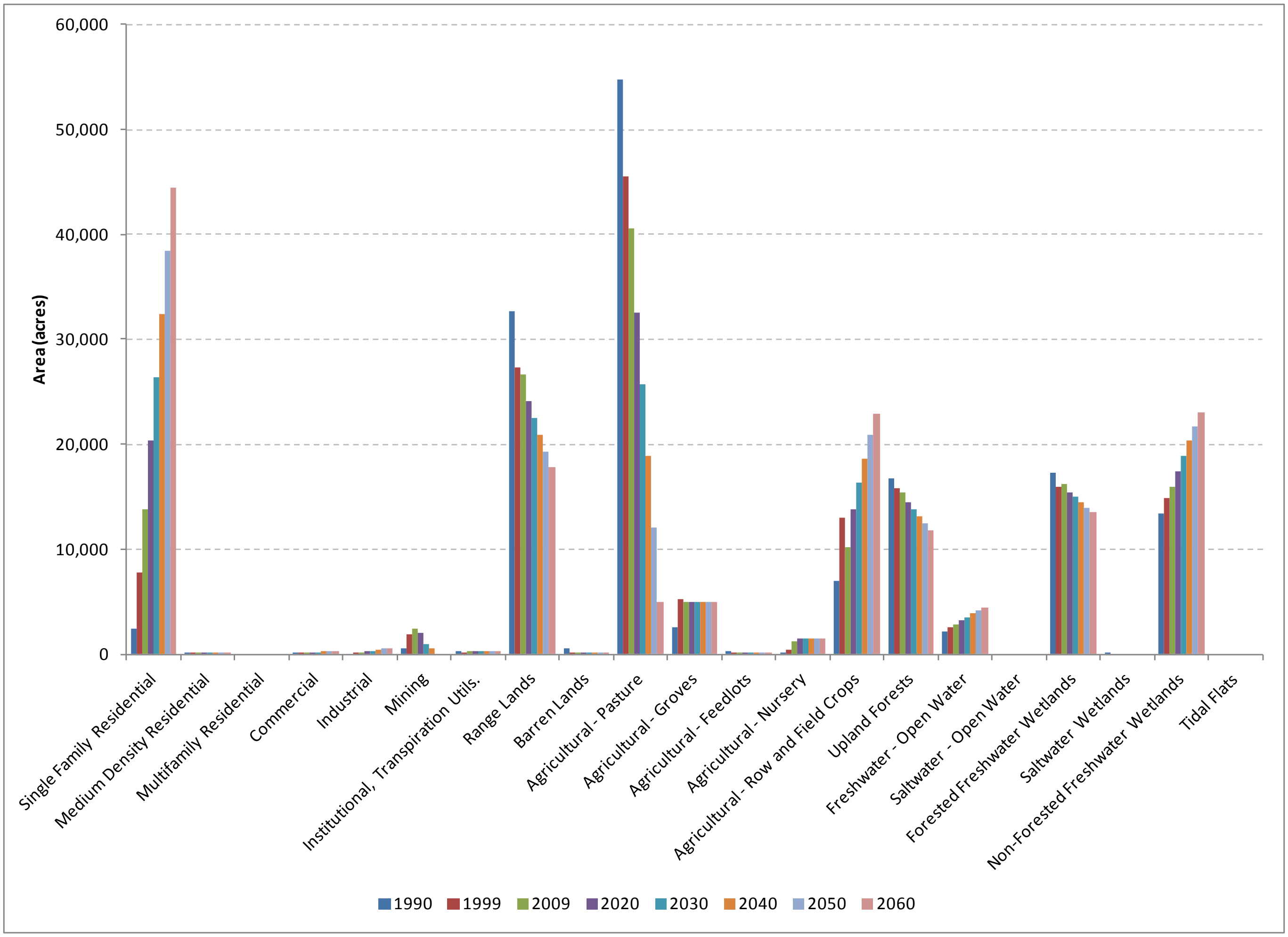
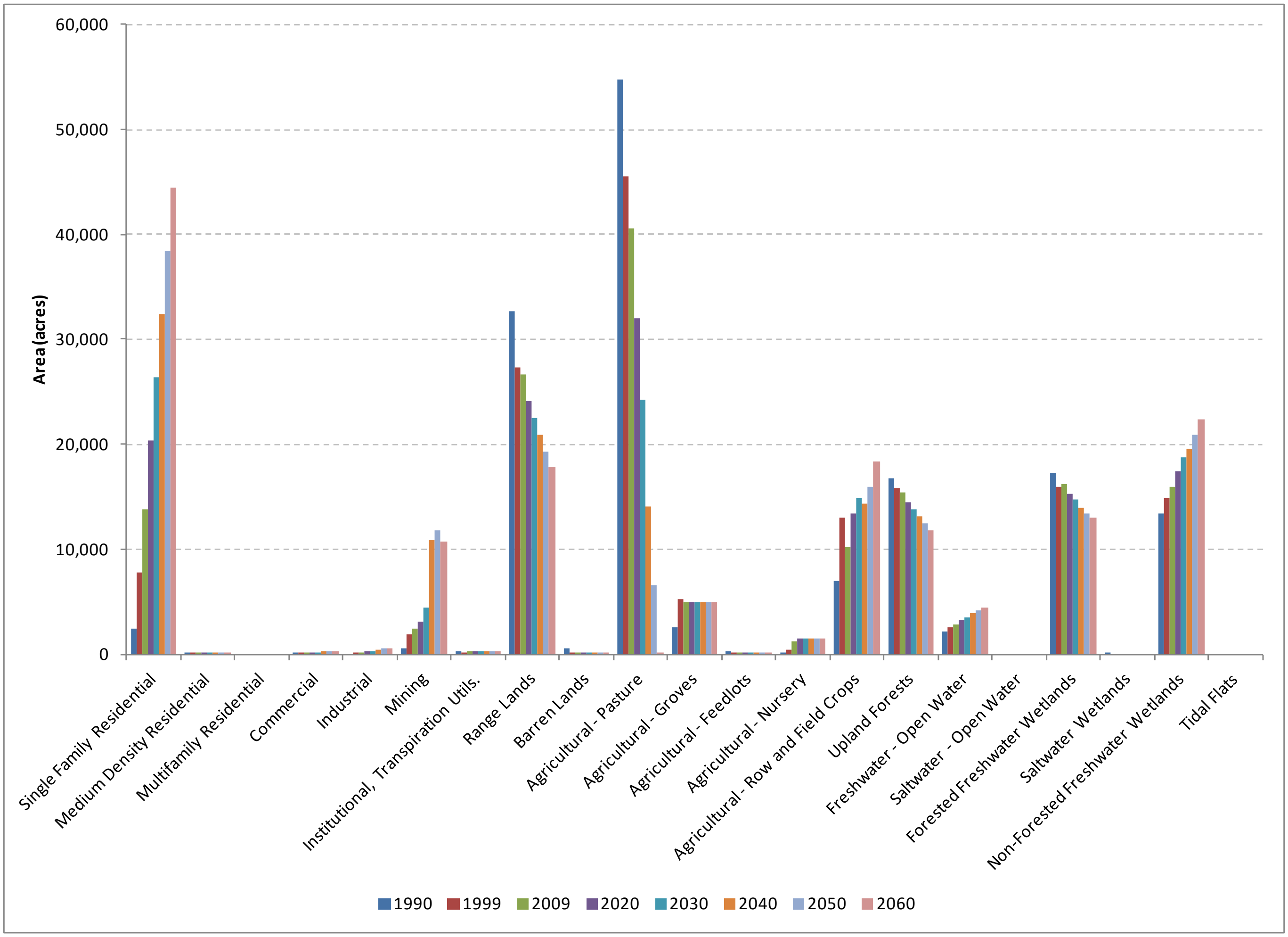


FIGURE 20

Land Use Projections With-Mining for Upper Myakka River Subwatershed through 2060 (includes Pine Level/Keys offsite alternative)



In terms of percent of the area being mined either past or present, the mining land use in the upper Myakka River subwatershed is relatively small when compared to other predominant land uses. These land uses were not plotted here, as there is negligible apparent change in the charts. Urban land uses, in particular single family residential, are projected to grow significantly in both the No Action Alternative (without mining) scenario and the with-mining scenario in the upper Myakka River subwatershed. In general, the main differences between the No Action Alternative and the with-mining scenario are a minor shift in the mining and pasture lands land uses.

Runoff coefficients for land uses were assigned using the Janicki-defined values shown in Table 3 for the No Action Alternative. For the alternatives with mines for the 100 percent capture case, the alternative's area was just removed from the computation. The runoff from the alternatives for the 50 percent capture case were addressed by assuming that 50 percent of the area captured had no runoff.

4.0 Capture Area Projections within Applicants' Preferred and Offsite Alternatives

The mining operation would be initiated by construction of the ditch and berm system to protect offsite properties from the dewatering required during mining. The rainfall falling inside the perimeter would remain within the mine stormwater management area–-or capture area until the land is released from reclamation requirements and not with the beneficiation plant[6]. The capture area for a given mine represents the portion of the mine which retains its stormwater runoff within the recirculation system, and the downstream surface water contribution is controlled for the period of time required to prepare the land for mining, mine the land, fill the mine pits with overburden and sand tailings, reclaim the land, and then monitor water quality until there is adequate documentation allowing the mine block to be released from within the industrial operations' boundaries (or, the mined area is simply called *released*). As discussed previously, a range of captured stormwater volume within this area was assumed (50 or 100 percent) to represent conservatively high surface water delivery reductions from the active mines for average and dry conditions.

The capture curves for each of the Applicants' Preferred and offsite alternative mines were developed as an independent analysis of possible mine acres impacted over the life of the mine. The following assumptions and conditions based on typical current mining practices were applied in determining the capture areas for each of the Applicants' Preferred Alternatives as a function of time during the individual mine's life cycle:

- Land clearing is initiated 1 year prior to mining.
- The ditch and berm system is constructed prior to land clearing.
- Areas to be isolated by the ditch and berm system and how the blocks would be mined were defined in the mine plan, based on current practices and typical dragline production rates (except for Wingate East Mine which uses a hydraulic dredge for about 60 percent of its mined area).
- The active mining operation includes the filling of the mine cuts with overburden and sand tailings.
- The reclamation parcel is re-connected to the watershed about 1 year after completion of reclamation (total of 3 years). This means that the ditch and berm system is removed at this time.
- CSAs require a minimum of 5 years for initial consolidation and 3 years for reclamation, with the overall average release being 10 years from last filling.
- The mine plan and the reclamation plan submitted with the applications were used to determine the years of capture.
- The capture curves developed in this manner included the mined areas and disturbed lands within the mine. Additional information about the development of the capture area curves for each mine is provided in Attachment B of this TM. For each of the four Applicants' Preferred mines, the capture areas developed in this manner are conservative – that is, the area captured in the AEIS exceeded the maximum acres reported to be mined at any one time as presented in the Applicants' mine plan data submitted in the applications. The shapes of the capture curves developed by AEIS assumptions (described above) and the areas reported by the Applicants (from plotting the "disturbed and not yet reclaimed" acres in each of the Applicants' mine plans) were similar. The independent estimate was applied in the AEIS process to encompass potential changes to the schedule that may cause slightly larger area impacts in the future. The variation between the maximum acres captured in any 1 year over the life of the mine – between the AEIS parcels and the mine plan data--is presented below:

[6] This statement is true for all future mines addressed in the applications. The capture analysis does not depend on where the ore is separated from the matrix. The area occupied by any future beneficiation plants would be relatively small (negligible relative to the whole mine) and stormwater would be managed at those sites under current industrial wastewater practices.

	Maximum Captured Acres at any 1 Year	
	AEIS Analysis	Mine Application Data
Desoto	15,312 ac	10,492 ac
Ona	15,096 ac	11,969 ac
Wingate	2,398 ac	1,653 ac
South Pasture Ext.	6,106 ac	3,933 ac

The capture areas are used to calculate the reduction to the surface water delivery from the active mines in each subwatershed by defining approximate acres and years that the mines would affect watersheds during mining and reclamation activities. The capture curves for each of the Applicants' Preferred mines and the Pine Level/Keys and Pioneer Tracts are described in the following sections.

The capture area analysis for each of the Applicants' Preferred mines was based on mine plan information in the respective permit applications received by the USACE. No permit application and no mine plans exist for any offsite alternatives (Pine Level/Keys Tract, Pioneer Tract, Site A-2, or Site W-2) so conceptual mine plans were generated for offsite alternatives evaluated quantitatively. The conceptual mine plans developed support the capture area analyses for the two offsite alternatives quantified (Pine Level/Keys and Pioneer Tracts) were based on a layout of mine blocks, dragline mine years, and reclamation parcels and schedules generated that were similar to those of the mining plans for the four Applicants' Preferred Alternatives (Desoto, Ona, Wingate East, and South Pasture Mine Extension). The conceptual plans were not based on input from the mine operators or prospecting data for the phosphate ore body within the prospective mine areas. The other two alternatives (Sites A-2 and W-2) were evaluated qualitatively so no conceptual mine plans were developed for these sites.

Table 9 provides a listing of the alternatives and how their area is distributed in the subwatersheds according to the GIS data that is generally available (see Figures 1 and 2 for the maps). However, there are some conditions that must be considered when using the GIS database. For example, the hydrologic boundaries are sometimes uncertain, especially in the flat land commonly found in southwest-central Florida. The GIS maps are precise, but not always accurate. This is the case for the Desoto and Pine Level/Keys Tract where the GIS mapped sizeable portions in subwatersheds that is not believed to be accurate. The Desoto mine boundary crosses into the Coastal subwatershed of Peace River, but on closer field review these portions are really in the Horse Creek subwatershed. Regardless of the mapping, issues like these will be addressed in greater detail during state permitting. Generally, if the mine boundary overlaps an adjacent subwatershed by a few hundred acres or less, it was attributed to mapping imprecision.

TABLE 9
Area of Alternatives in Watersheds and Subwatersheds as Mapped on GIS Coverage

Alternative	Watershed	Subwatershed	Smaller Creeks/Streams in Subwatershed(1)	Acreage
Desoto Mine	**Myakka River**	Big Slough	North Cocoplum Waterway	355
			Wildcat Slough	1
			Big Slough Canal	19
	Peace River	Coastal Lower Peace (2)	Lower Horse Creek	4,030
		Horse Creek	Brandy Branch	893
			Middle Horse Creek	2,826
			Buzzard Roost Branch	8,244
		Peace at Arcadia	McBride Branch	1,919
			Total Acreage	**18,287**
Ona Mine	**Myakka River**	Upper Myakka River	Wingate Creek	269
	Peace River	Horse Creek	Horse Creek Headwaters	4,216
			Upper Horse Creek	839
			Brushy Creek-Horse Creek	12,187
		Peace at Arcadia	Troublesome Creek	1,771
			Oak Creek	3,037
			Total Acreage	**22,320**
Wingate East Mine Extension	**Myakka River**	Upper Myakka River	Wingate Creek	3,216
			East Fork of the Manatee River	65
	Peace River	Horse Creek	Horse Creek Headwaters	355
			Total Acreage	**3,635**
South Pasture Mine Extension	**Peace River**	Horse Creek	Horse Creek Headwaters	20
			Brushy Creek-Horse Creek	5,304
		Payne Creek	Lower Payne Creek	409
		Peace at Arcadia	Troublesome Creek	1,781
			Total Acreage	**7,514**
Pine Level/Keys Tract	**Myakka River**	Big Slough	North Cocoplum Waterway	1,588
			Wildcat Slough	10,762
			Mud Lake Slough	3,295
			Big Slough Canal	5,082
		Upper Myakka River	Owen Creek	450
			Tatum Sawgrass Swamp	49
	Peace River	Coastal Lower Peace (2)	Lower Horse Creek	66
		Horse Creek	Buzzard Roost Branch	3,418
			Total Acreage	**24,711**
Pioneer Tract	**Myakka River**	Upper Myakka River	Owen Creek	9
	Peace River	Horse Creek	Upper Horse Creek	6,216
			Brushy Creek-Horse Creek	4,263
			Middle Horse Creek	345
		Peace at Arcadia	Troublesome Creek	3,075
			Oak Creek	8,491
			Limestone Creek-Peace River	1,855
			Peace River Branch	1,005
			Total Acreage	**25,259**
Site A-2	**Peace River**	Charlie Creek	Buckhorn Creek	64
		Peace at Zolfo Springs	Little Charlie Creek	7,771
			Thompson Branch	354
			Total Acreage	**8,189**

TABLE 9
Area of Alternatives in Watersheds and Subwatersheds as Mapped on GIS Coverage

Alternative	Watershed	Subwatershed	Smaller Creeks/Streams in Subwatershed(1)	Acreage
Site W-2	**Myakka River**	Upper Myakka River	Oglegy Creek	8,249
			Maple Creek	360
			Tatum Sawgrass Swamp	1,110
			Total Acreage	**9,719**

Basin Boundary Source: Hydrologic Unit Maps from NRCS (2013)

(1) The GIS map for alternative and subwatershed boundaries overlap, but small areas were considered minor or an artifact of GIS coverage precision of mine and watershed boundaries.

(2) The GIS map from the NRCS has some of Horse Creek subwatershed in the Coastal subwatershed, but this area was assigned to the Horse Creek subwatershed.

4.1 Desoto Mine

The site of the Desoto Mine is mostly within the Horse Creek subwatershed, but a portion is within the Peace River at Arcadia subwatershed. This mine would require the construction of an initial CSA, a beneficiation plant, and initial mine infrastructure corridors. The Desoto Mine anticipated schedule has mining to continue for the first 13 years of the mine life, and reclamation to continue to mine year 23. The Desoto Mine would be anticipated to begin mining in 2021. The capture area graph for the Desoto Mine is presented in Figure 21. As indicated in this figure, mining activities would affect both of these subwatersheds concurrently for much of the duration of the mining activities planned for this mine. This alternative will be reclaimed by 2060, and probably much sooner.

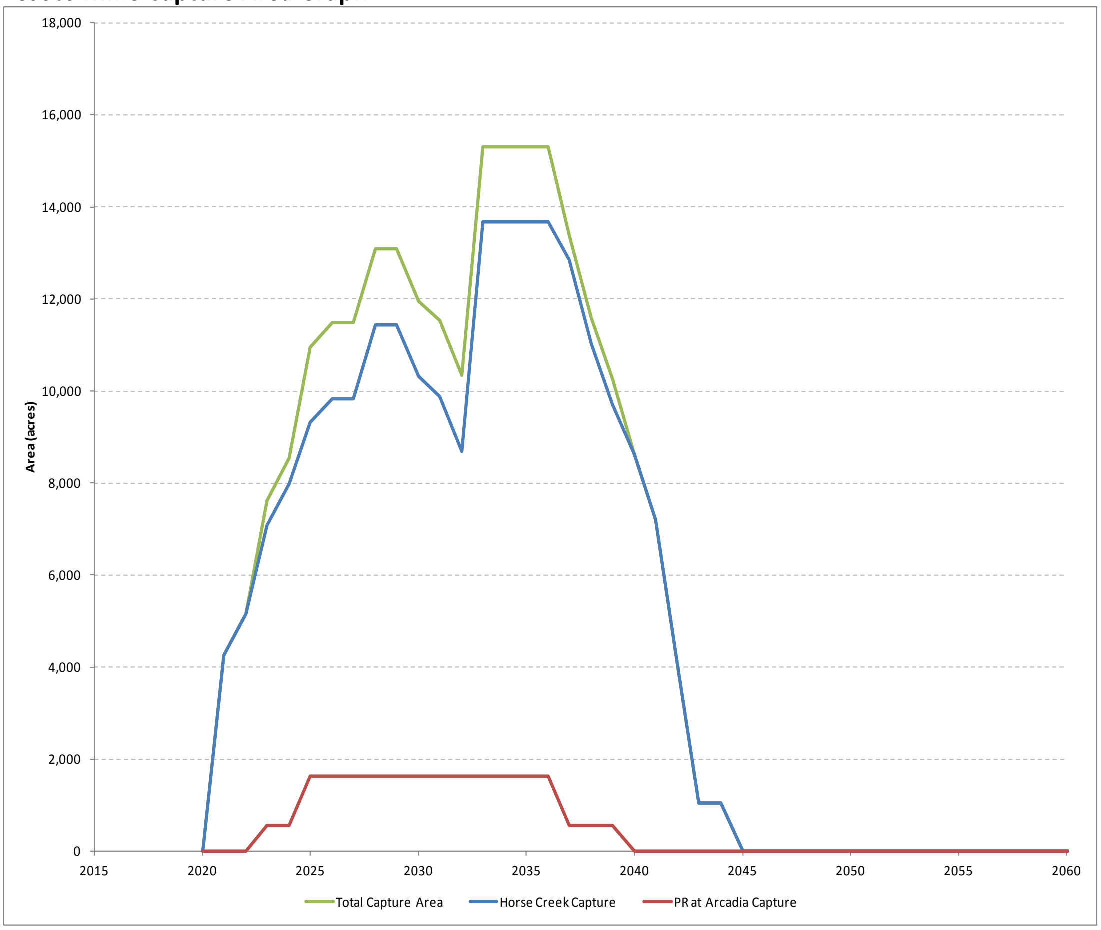
4.2 Ona Mine

The Ona Mine site is mostly within the Horse Creek subwatershed, but includes some small portions within the Peace River at Arcadia subwatershed and the upper Myakka River subwatershed. The Ona Mine would use the CSAs in two existing mines to support the initial stages of mining. This would allow mining to begin without having to construct a CSA on unmined ground. The use of existing CSAs would also allow the use of mine corridors in these two existing mines, reduce the CSA footprint in the alternative, and reduce overall capture time and acres for this mine. The estimated capture area graph for the Horse Creek, Peace River at Arcadia, and upper Myakka River subwatersheds from the Ona Mine is presented in Figure 22. Mining at the Ona site would be anticipated to begin in 2020. The Ona Mine anticipated schedule has mining to continue for the first 29 years of the mine life, and reclamation to continue to mine year 45. This alternative will not be fully reclaimed by 2060, but very close to being finished.

The capture area curve for the Ona site reflects the gradual increase in acreage included in the recirculation system boundary over the roughly 29-year duration of active mining, with a gradual return of lands to contribute to downstream flows as reclamation rates gradually exceed the mining rates and result in a net decrease in the capture area acreages. On the basis of this analysis, the peak years of capture would be predicted to occur toward the end of the period of matrix extraction, after which reclamation and land release would gradually return the full mine footprint to a state of contributing runoff to downstream waters.

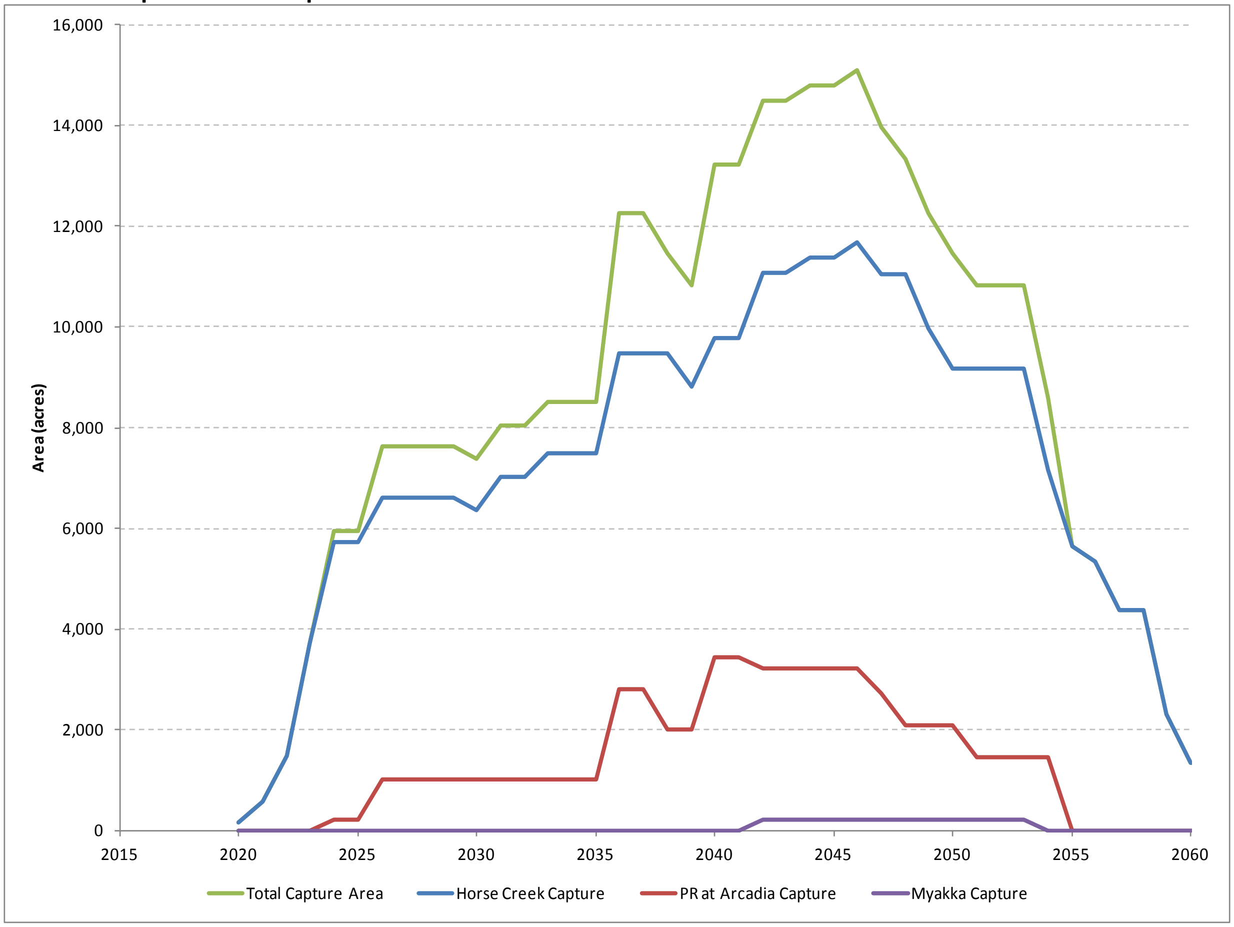
The mining sequence indicates that for approximately the first 5 years of mine operations, the areas tributary to the Peace River at Arcadia and Myakka River subwatersheds would not be impacted by the Ona Mine. The acreages within these two subwatersheds would be relatively small at any time during the life of the mine, and the durations of influence much shorter than the likely influence on the Horse Creek subwatershed. The area of this alternative in the Upper Myakka River subwatershed was not analyzed in detail due to its small size (about 269 acres).

FIGURE 21
Desoto Mine Capture Area Graph



Note: Derived from the sequence of mining as provided by Mosaic in the Section 404 permit application.

FIGURE 22
Ona Mine Capture Area Graph



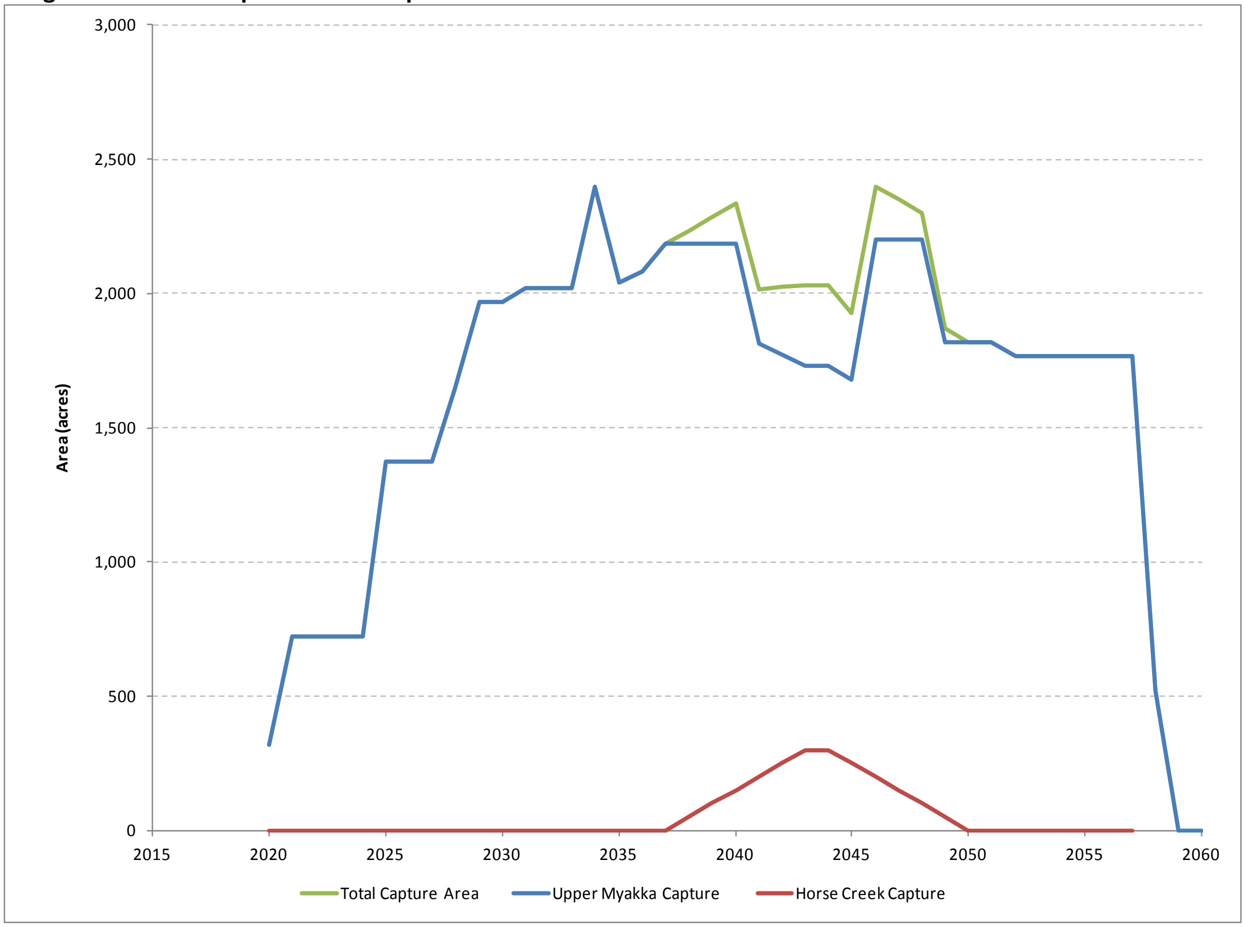
Note: Derived from the sequence of mining as provided by Mosaic in the Section 404 permit application.

4.3 Wingate East Mine

The Wingate East Mine site is almost[7] entirely in the upper Myakka River subwatershed, with an additional portion in Horse Creek. This mine extension would use the CSAs, beneficiation plant, and mine infrastructure corridors of the Wingate Creek Mine. The capture area graph for the Wingate East Mine is presented in Figure 23. The Wingate East Mine anticipated schedule has mining to continue for the first 28 years of the mine life, and reclamation to continue to mine year 41. Mining within this extension would begin in 2020. Mine blocks east of Duette Road would be mined using a dragline (about 32 percent of the mine) and the mine blocks west of the road would be wet dredged (about 60 percent of the mine; 8 percent is unmined). The schedule indicated that wet dredging would commence about 10 years ahead of the dragline portion of the mine, but this area would not be released until near the end of the mine life. Because the wet dredge process does not facilitate the storage of additional water onsite, it was assumed that a smaller amount of capture of stormwater would occur. Reductions in surface water from the mine capture were only applied at half the area shown on the capture curve for this mine. This alternative will be reclaimed by 2060. The area of this alternative in Horse Creek is small (about 300 acres) and it was not analyzed in detail.

[7] Wingate East is at the far northeast corner of the Myakka watershed and infringement outside this watershed's boundary would be negligible. Note that the GIS maps of the different boundaries sometimes do not match at the flat uplands at the headwaters of watersheds.

FIGURE 23
Wingate East Mine Capture Area Graph

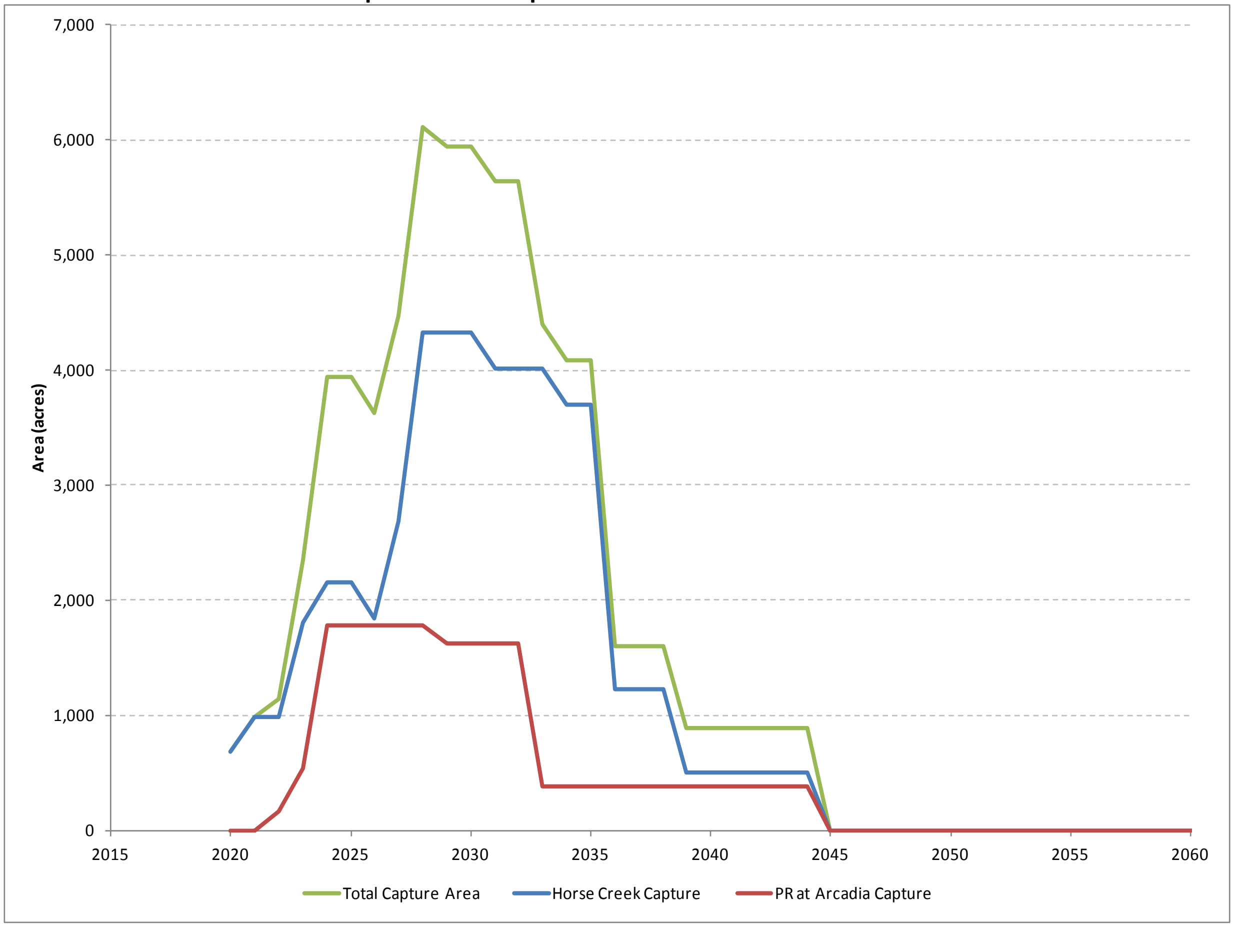


Note: Derived from the sequence of mining as provided by Mosaic in the Section 404 permit application.

4.4 South Pasture Mine Extension

The South Pasture Mine Extension site is mostly in the Horse Creek subwatershed, with a small area within the Peace River at Arcadia and Payne Creek subwatersheds. This mine extension would initially use the CSAs and mine infrastructure corridors of the parent mine, the South Pasture Mine. The capture area graph for the South Pasture Extension is presented in Figure 24. The area of this alternative in Payne Creek is small (about 400 acres) and it was not analyzed in detail so its capture curve is not included. Mining into this extension would begin in 2020. This alternative will be reclaimed well before 2060.

FIGURE 24
South Pasture Mine Extension Capture Area Graph



Note: Derived from the sequence of mining as provided by Mosaic in the Section 404 permit application.

4.5 Pine Level/Keys Tract

The Pine Level/Keys Tract is mostly in the Myakka River watershed, specifically in the Big Slough Basin. This mine is considered a stand-alone alternative as well as an extension to the Desoto Mine. As a stand-alone mine, however, it would need a new beneficiation plant (not located in Manatee County because of a county ordinance prohibiting beneficiation plants) and a CSA that would have to be constructed prior to mining, likely delaying the date before ore can be processed.

The northeast corner of the Pine Level/Keys Tract lies in the Horse Creek subwatershed according to the GIS watershed boundary data. This area is primarily northeast of State Road 70 (about 3,055 acres) and a small area on the south side that drains eastward. There is no application for Pine Level/Keys and Mosaic indicated that it will not be able to review the site until a future date. The timing of future mining in this tract as an extension to Desoto Mine is such that the capture area would peak after most of the Applicants' Preferred Alternatives would be mined (peak impact here after 2045) and not contribute to the highest capture areas totals.

The conceptual mine plan was developed to support the analysis of direct and indirect effects of the Pine Level/Keys Tract as an independent alternative, and the analysis of its contribution to cumulative impacts as an extension to the Desoto Mine. The capture curve shown in Figure 25 was developed generically for the life of the mine and the total capture area was applied at the starting year of mining for both cases (independent or as an extension). The main difference in the two analyses is when the mining starts. For the independent analysis, the Pine Level/Keys Tract alterative was assumed to begin mining in 2025 (Figure 26). However, the time required to secure all rights and permits, as well as to mobilize, is unknown. This alternative will be reclaimed beyond 2060 with this conceptual plan.

As an extension to Desoto Mine this alternative begins in 2034. It was assumed that the Desoto Mine CSAs would be used for the first 6 years of mining in the extension, with the following years at Pine Level/Keys Tract having new CSAs. The conceptual plan was formulated assuming that each new CSA requires 2 years for construction, 5 years for consolidation, and 3 years for reclamation (10 years total). The CSAs would be filled for approximately 2 years and rested for 1 year, and each CSA would have 3 to 5 cycles during its active life. The Desoto Mine CSAs were assumed to have capacity to manage the remaining percentage of phosphatic clays beneficiated at the Desoto plant for the startup of Pine Level/Keys Tract. If not, then a new CSA will be required sooner at Pine Level/Keys Tract, as it would if it were an independent alternative. This alternative will be reclaimed beyond 2060 with this conceptual plan, but it is started later too.

FIGURE 25
Pine Level/Keys Tract Conceptual Capture Area Graph

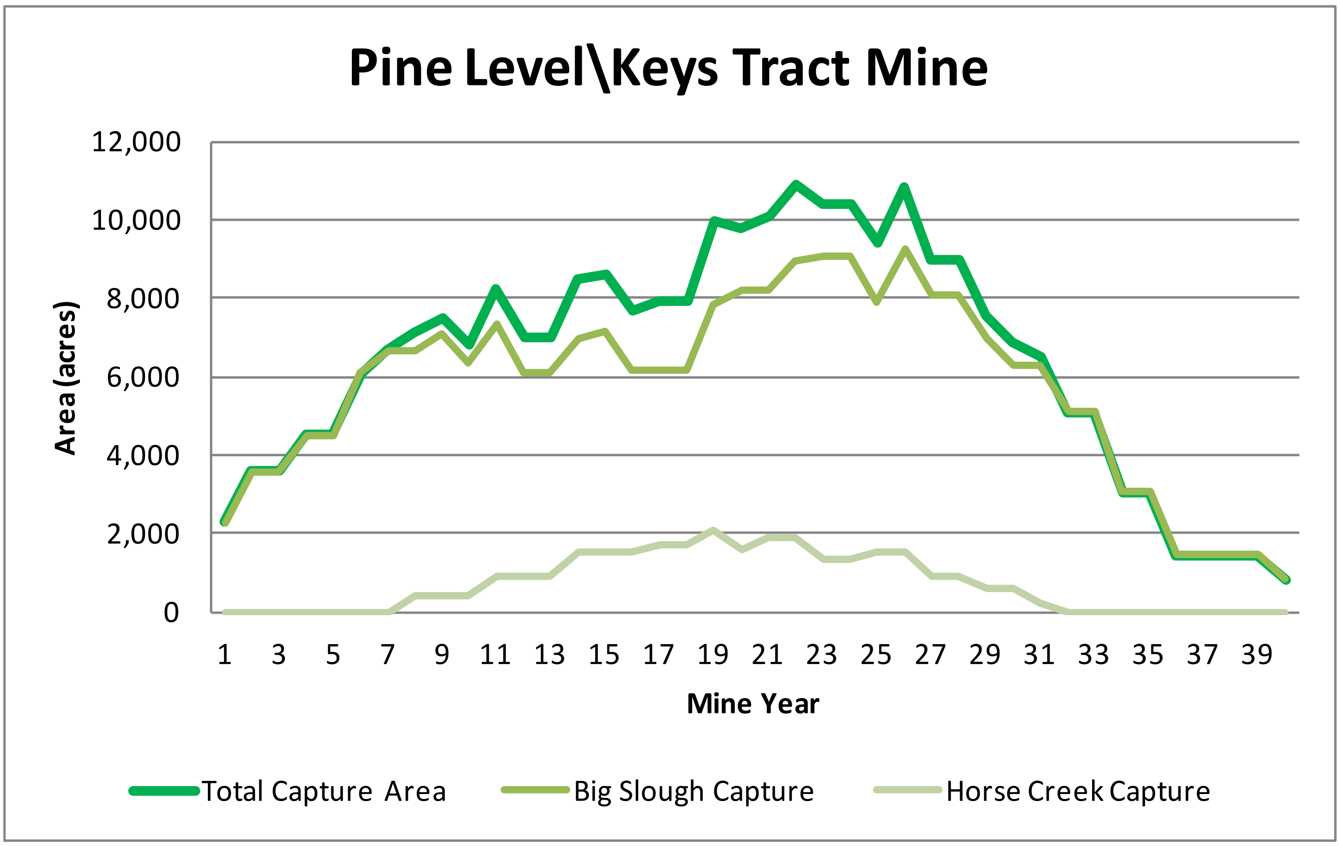
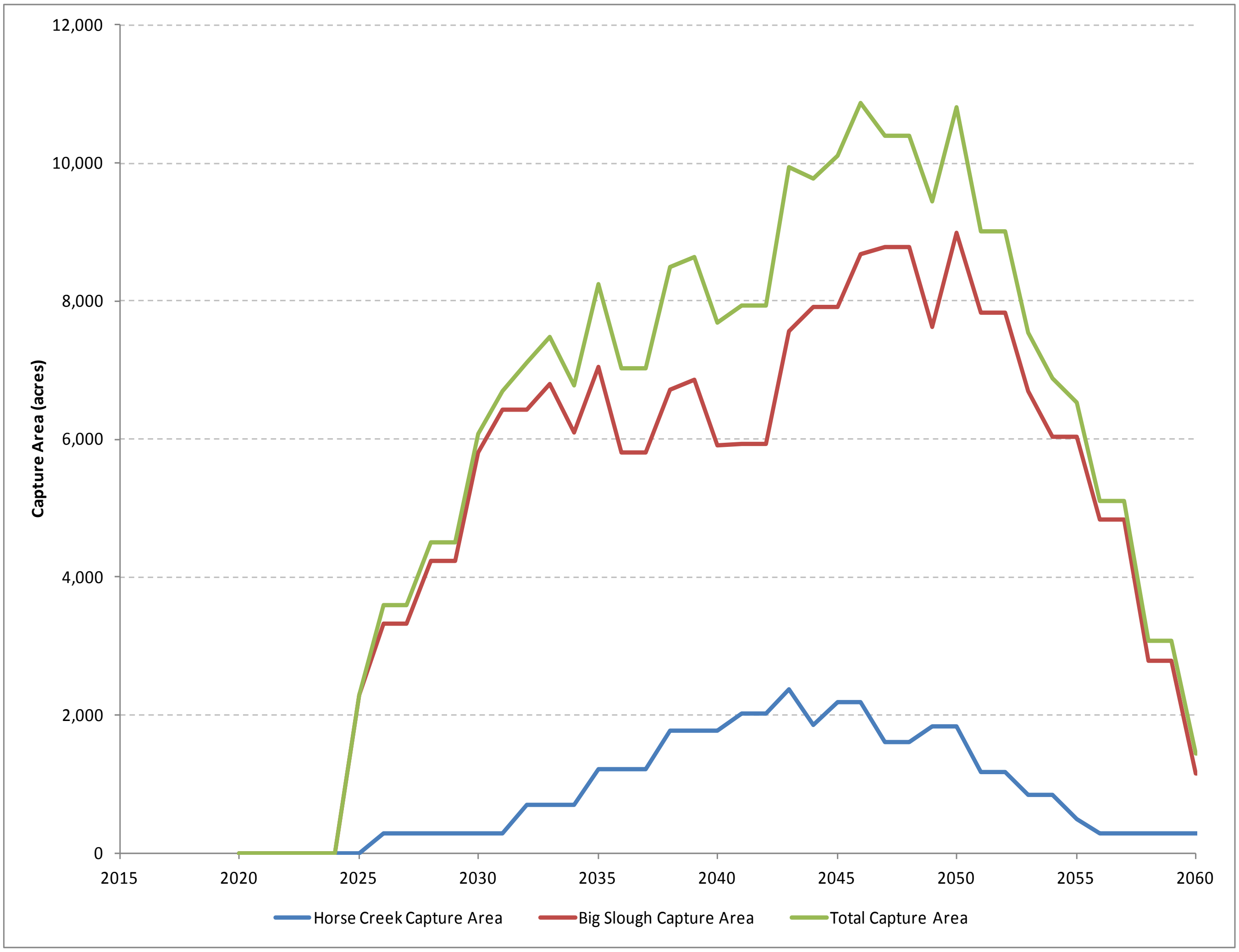


FIGURE 26
Pine Level/Keys Tract Conceptual Capture Area Graph as an Independent Alternative Beginning in 2025



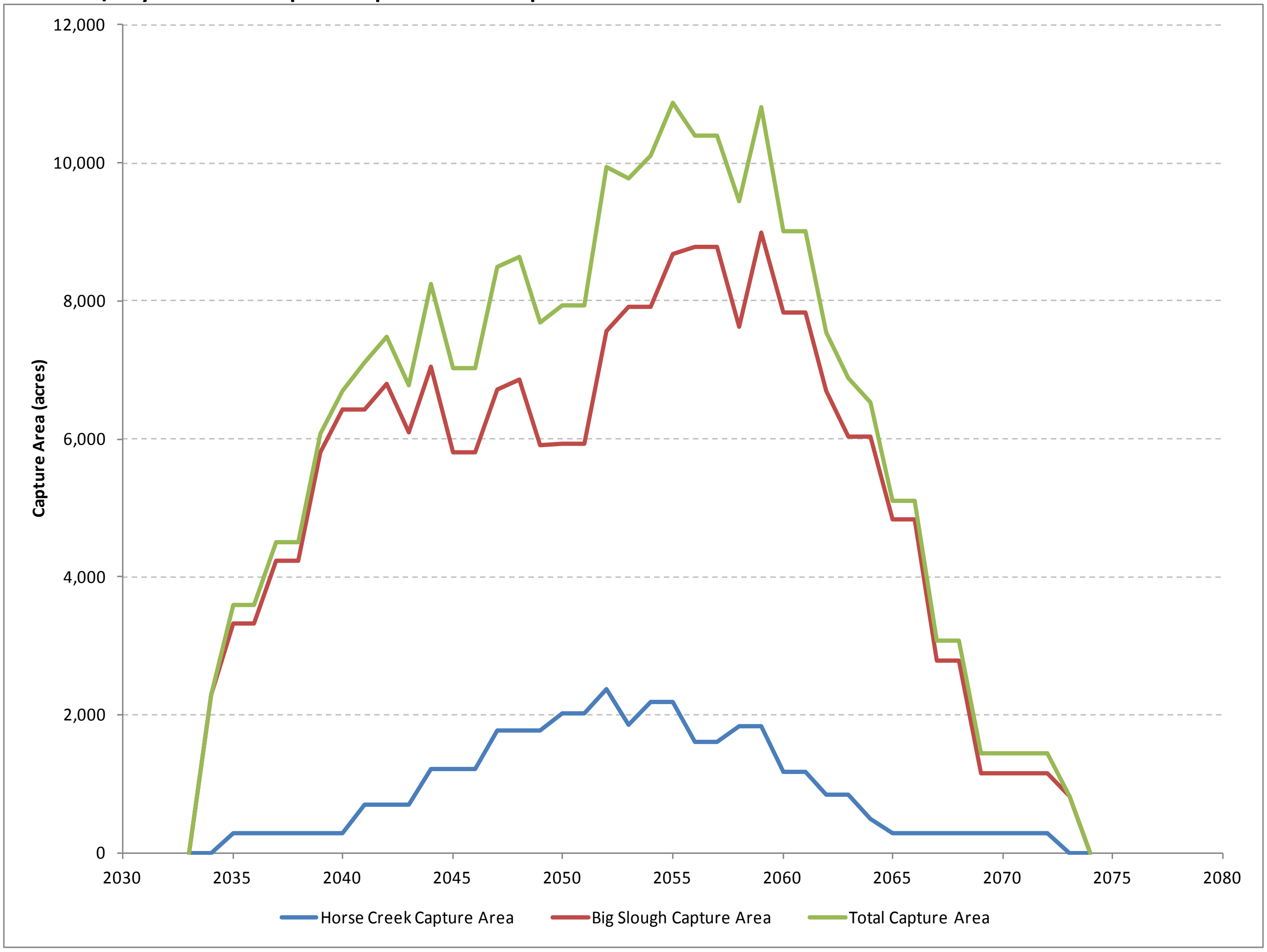
For the Pine Level/Keys Tract conceptual mine plan, the following assumptions were applied:

- Four draglines will be employed – transitioning from the south (from the Desoto Mine).
- Each dragline will excavate an average of 180 acres of active mining area per year.
- The ditch and berm system will be constructed 1 year prior to mining.
- At the end of mining, each mined-out area is filled with sand tailings – 3 years.
- Reclamation involves 2 years for recontouring and revegetation, and 1 monitoring year for vegetation establishment prior to re-connecting the area to the watershed (removing the ditch and berm system).

The capture area curve for the Pine Level/Keys Tract is shown in Figure 27 as though it were an extension or continuation of the Desoto Mine. The most likely development of this alternative as an extension would have Pine Level/Keys Tract using the Desoto beneficiation plant for separating the matrix. The conceptual mine was laid out to have the following acres, which represent typical percentages of the Pine Level/Keys Tract total mine acres based on current practice at the phosphate mines in the CFPD:

- Total acres: 24,509 ac 100 percent
- Preserved: 3,797 ac 16 percent
- Mined: 20,307 ac 84 percent
- CSAs: 2,817 ac 12 percent

FIGURE 27
Pine Level/Keys Tract Conceptual Capture Area Graph as an Extension to the Desoto Mine



Note: Derived from a conceptual mine plan assuming this land area is developed as an extension of the Desoto Mine.

4.6 Pioneer Tract

The Pioneer Tract is mostly in the Peace River watershed, split between the Horse Creek and the Peace River at Arcadia subwatersheds. As with the Pine Level/Keys Tract this mine would also most likely be an extension, in this case to the Ona Mine, but it is also being analyzed as a stand-alone alternative. As a stand-alone mine, however, a new beneficiation plant would be required prior to start of mining. A conceptual mine plan was developed to support the analysis of the potential effects of the Pioneer Tract on surface water quantities delivered downstream within the indicated subwatersheds, with the intent of estimating the mine capture area over the life of the mine. The same general assumptions about developing the conceptual mine plan for the Pine Level/Keys Tract apply here also (e.g., independently done with limited data on when it would occur, and so forth). A generic capture area curve for the life of the mine was developed and then applied to the assumed start date of the independent alternative or mine extension, depending on the analysis.

The conceptual mine plan for the Pioneer Tract is based on a layout of dragline mine years and reclamation parcels, which is based on the spatial extent of the mine and the following assumptions:

- Four draglines will be employed – transitioning from the south (from the Ona Mine).
- Each dragline will excavate an average of 200 acres of active mining area per year.
- The ditch and berm system will be constructed 1 year prior to mining.
- At the end of mining, each mined-out area is filled with sand tailings at 3 years.
- Reclamation consists of 2 years for recontouring and revegetation and 1 monitoring year for vegetation establishment prior to re-connecting the area to the watershed (removing the ditch and berm system).

The mine is assumed to use the Ona Mine CSAs for the first 8 years of mining, with the assumption that the CSAs require 2 years for construction, 5 years for consolidation, and 3 years for reclamation. The CSAs would be filled for approximately 2 years and rested for 1 year, and each CSA would have 3 to 5 cycles during its active life. The CSAs would consume approximately 29 percent of the mined land within the Pioneer Tract. If the Pioneer Tract was developed as an independent alternative, then a new onsite CSA and nearby beneficiation plant will be required which may alter the early years of the conceptual mine plan.

The mine was laid out to have the following acres, which represent typical percentages of the total mine acres as currently practiced at the phosphate mines in the CFPD:

• Total acres	25,231 ac	100 percent
• Preserved	3,700 ac	15 percent
• Mined	21,100 ac	85 percent
• CSAs	6,100 ac	29 percent

The Pioneer Tract is assumed to use the Ona beneficiation plant for beneficiating the matrix if it is implemented as an extension of Ona. The rate of reclamation would be determined by the rate of mining, the rate of sand tailings fill into the mined acres, and the final reclamation land form. For the purposes of this alternative, it was assumed that the initial release of reclamation occurs 3 years after sand tailings fill is completed.

As an independent alternative, the capture curve for the Pioneer Tract shown in Figure 28 was applied assuming that the start date of mining is 2025. The capture area curve for the Pioneer Tract as though it were an extension or continuation of the Ona Mine beginning in 2048 is shown in Figure 29. In either conceptual plan, the alternative will be reclaimed beyond 2060.

FIGURE 28
Pioneer Tract Conceptual Capture Area Graph as an Independent Alternative Beginning in 2025

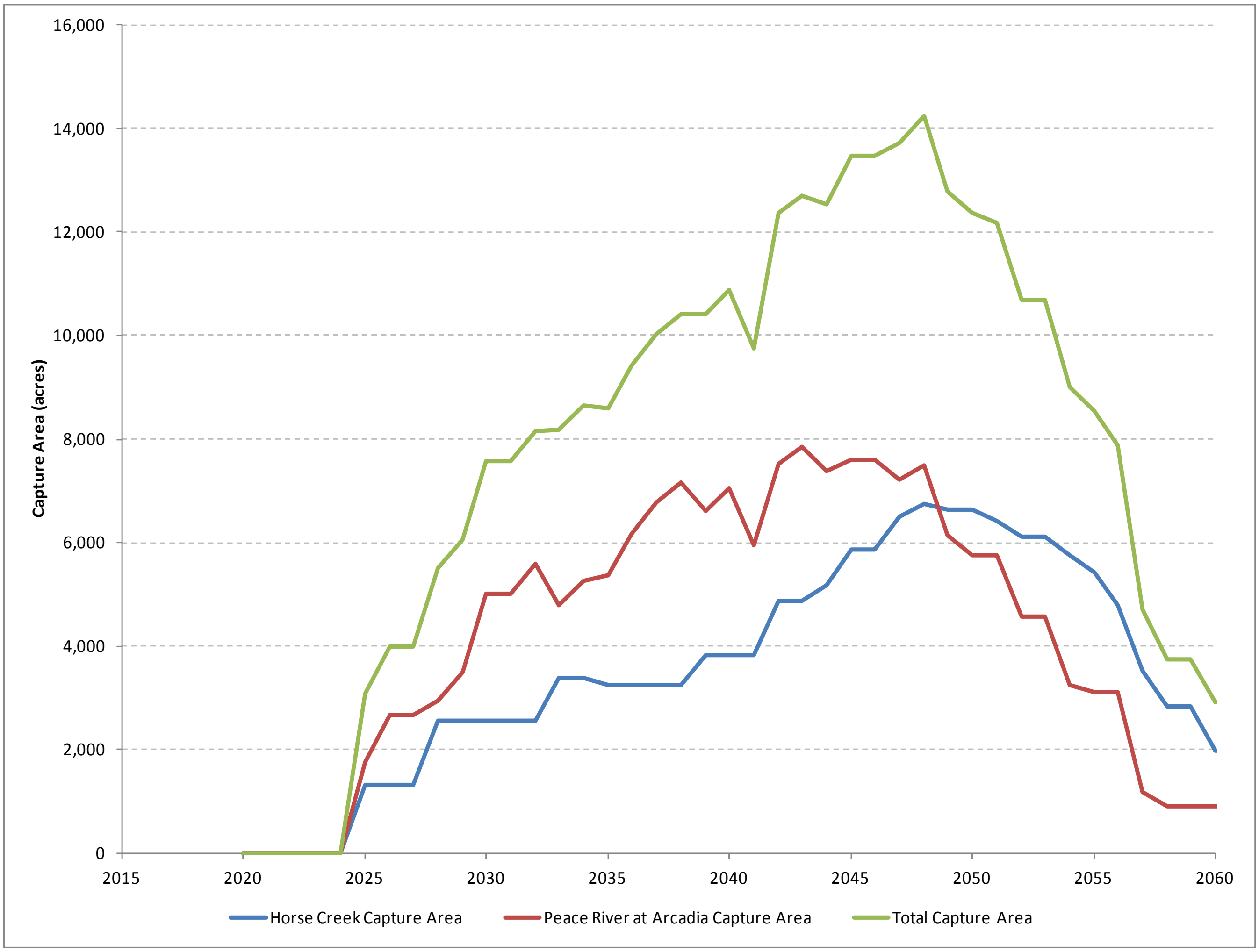
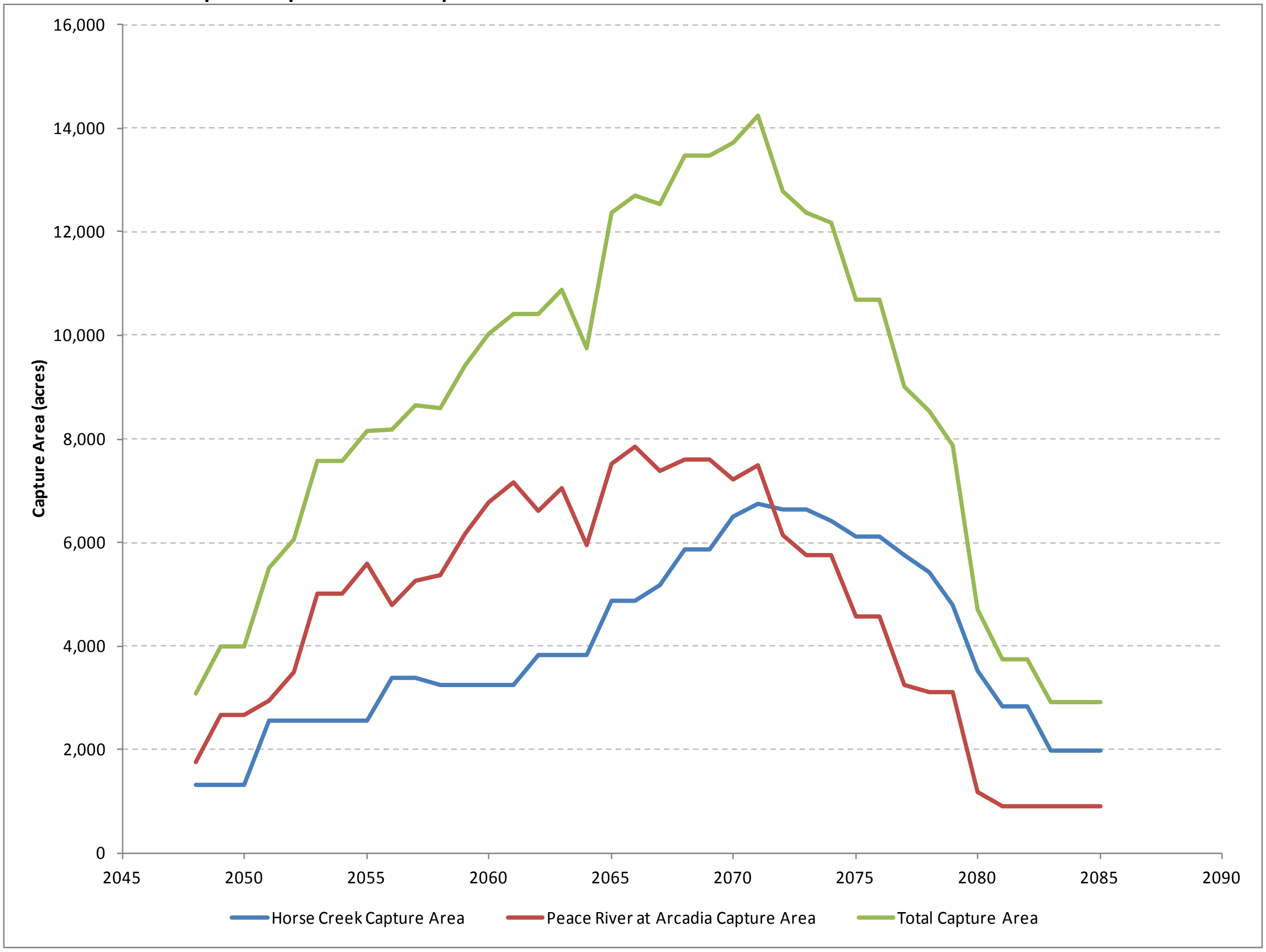


FIGURE 29
Pioneer Tract Conceptual Capture Area Graph as an Extension to the Ona Mine



Note: Derived from a conceptual mine plan assuming this land area is developed as an extension of the Ona Mine.

5.0 Stream Flow Projections and Evaluation of Hydrologic Impacts on Surface Water Delivery

An evaluation of runoff characteristics and flow projections for each subwatershed was conducted with the projected land use changes through 2060 and the capture area analysis for each of the alternatives analyzed quantitatively. Projections were made for individual alternatives and the combined effect of multiple alternative mines operating at the same time (that is, all mining alternatives operating as scheduled, including the Pine Level/Keys and Pioneer Tracts that would most likely operate as extensions of adjacent mines). The predicted effects on each subwatershed and on the entire watershed are presented in this section. This evaluation involved calculating area-weighted average runoff coefficients for each subwatershed for 2020, 2030, 2040, 2050, and 2060 for each corresponding land use projection and capture area schedule for each mine. In some instances, 2035 and 2045 years were estimated to be sure that peak capture conditions were estimated and included, as described below. The analysis was conducted for wet and the dry seasons during an average rainfall year, and for wet and dry seasons during a low rainfall year. The impact of the mines on downstream surface water delivery was estimated with all of the stormwater within the capture area being retained (100 percent capture) and half of the onsite stormwater retained (50 percent capture).

For each analysis described in this section, a spreadsheet-based computation was conducted by applying precipitation to the area-weighted runoff coefficients derived from the many soil/land use polygons. The mine capture area curves were applied for each time period on each subwatershed to remove that amount of area from contributing flow. The 50 percent capture analysis was conducted based on runoff from half of the mine area captured, where the 100 percent capture case removed the entire active mine's area from the flow prediction. A revised area-weighted runoff coefficient for the subwatershed without that land area was computed to evaluate the change to the coefficient for discussion purposes. Each mine was analyzed individually, and the combined effects of multiple mines operating with overlapping periods of activity were also evaluated for consideration in the cumulative impacts section of the AEIS.

This section in the TM is divided as follows:

- No Action Alternative
- Desoto Mine
- Ona Mine
- Wingate East Mine
- South Pasture Mine Extension
- Pine Level/Keys Tract
- Pioneer Tract
- Site A-2 and Site W-2
- Cumulative Impacts to Stream Flows at:
  - Horse Creek
  - Peace River at Arcadia
  - Upper Charlotte Harbor
    - Peace River contribution
    - Myakka River contribution
    - Peace and Myakka River combined

With each analysis, the effect of individual mines may be small, but the combined additive effect estimated with all Applicants' Preferred Alternatives operating, including the Pine Level/Keys and Pioneer Tracts, presents the largest potential impact in the Peace River. When the capture curves were added together, the highest area captured in Horse Creek was around 2035; thus, a 2035 year estimate was added to the results in this subwatershed. The combined effect of mining on the Myakka River is addressed by the individual mines (Wingate East and Pine Level/Keys) since there are not multiple mines operating in the same river/creek reach at the same time (i.e., both flow directly into Charlotte Harbor). A range of analyses are presented in this section so different mines can be documented using both conservative and extreme assumptions during both average and low rainfall conditions. Low rainfall conditions were estimated as the 20th percentile of the annual rainfall totals for the period of record (i.e., 80 percent of the years had higher rainfall) as described previously. Additional analyses are presented in Section 6 on low flow effects on the utilities that use surface water as part of their source.

Two offsite alternatives, Site A-2 and W-2, did not have their impact computed quantitatively. Since there was no information about their potential mining potential, it was determined that it would be too speculative to generate a plan (schedule). However, these two sites are discussed qualitatively by comparing their location and size to the other alternatives' impacts. From Table 9, some of the watershed and alternative boundaries overlap such that there are small areas that may reside in adjacent subwatersheds on the maps, but it is uncertain how accurate these boundaries are. For areas less than about 500 acres, the impact on flow would be less than 1 cfs under average rainfall conditions. These areas are minor, differences would be hard to detect, and are within rounding errors of the calculations. A 50 percent capture rate would be proportionately smaller. This section provides the estimates of impacts in context of future land use change.

5.1 No Action Alternative Impacts on Runoff Characteristics and Stream Flow

The No Action Alternative conditions are defined in Chapter 2 of the AEIS whereby Section 404 permits would be denied but the applicants could modify their plans to mine in upland areas where reasonable to do so. So while the No Action Alternative does not prohibit all mining, the area being mined would be less than under the Applicants' Preferred Alternatives or the offsite alternatives. To create the most conservative case for the No

Action Alternative to determine maximum impact, it was assumed that no mining would take place. This assumption results in the maximum differences in flow rates when comparing No Action Alternative conditions to any of the Applicants' Preferred Alternatives or offsite alternatives. Therefore, all No Action results listed here are for No Action, No Mining.

As discussed previously, the land use and its effect on the runoff coefficients was the variable that changed in the No Action Alternative. These changes included allowing the existing mines to return to a mixture of agricultural, urban, and natural land uses according to their scheduled completion. This change resulted in an increase in flow rates in most subwatersheds as follows:

- Peace River at Arcadia, 9.8 percent increase;
- Horse Creek, 3.5 percent increase;
- Peace River, 11.1 percent increase;
- Upper Myakka River14.8 percent increase; and
- Entire Myakka River watershed, 5.3 percent increase.

The increase in flow was higher in the upper Myakka River subwatershed because the historical trend has been higher. Big Slough Basin was not estimated to change because there are no existing mines in this subwatershed and the urban development here is clustered around a canal system near Charlotte Harbor. Growth in the subwatershed will occur but it is unknown how the drainage patterns through the canals will affect flow near Myakkahatchee Creek. The SWFWMD has delayed developing and minimum flow and level (MFL) study on Myakkahatchee Creek because of the complicated flow patterns and lack of available data. Consequently, the No Action Alternative for Big Slough subwatershed assumed constant future runoff conditions.

The flow in the Peace River, as well as in all subwatersheds in west-central Florida, is highly variable and dependent on rainfall (see Section 2.4.2 above). The USGS has studied the yield of surface water in several subwatersheds and determined that there are periods of time when stream flow can be very low or cease flowing when the groundwater levels are low. However, this occurs primarily in river segments north of Fort Meade (Metz and Lewelling, 2009). In general, both the Peace and Myakka River watersheds are much larger than the area that would be impacted by the Applicants' Preferred Alternatives or offsite alternatives, either individually or combined. Peace River at Arcadia flow includes upstream contributing areas Peace River at Zolfo Springs (and northward), Charlie Creek, and Payne Creek. Horse Creek, Joshua Creek, and Prairie Creek (includes Shell Creek), and Peace River at Arcadia contribute to the Charlotte Harbor. The upper Myakka River and lower Myakka River subwatersheds are defined to be separated at the USGS gage near Sarasota. Big Slough Basin is a subwatershed in the lower Myakka River subwatershed.

The estimated No Action Alternative flow conditions for the average annual rainfall is presented in Tables 10 through 12 and the low rainfall years in Tables 13 through 15. Each prediction was based on runoff coefficients allocated to the soil type and land use as described previously in Section 2.3 of this TM. The flow conditions are provided for both wet and dry seasons and for the annual average flow at each 10-year increment. These data were used to compare the mining alternatives discussed in the remainder of this section and they are plotted alongside each alternative presented.

5.2 Desoto Mine Impacts on Runoff Characteristics and Stream Flow

The effects of the Desoto Mine were calculated by changing the runoff coefficients in the Horse Creek and Peace River at Arcadia subwatersheds with this mine's capture area accounted for over the life cycle of the mine. The projected flows and percent change from 2009 levels was estimated seasonally and annually for 100 percent capture of the capture area runoff and for 50 percent capture of the capture area runoff. Projections were also performed for an average rainfall year and for a low rainfall year. The capture curves indicate that the most area under surface water management controls for this alternative is around 2035 for the Horse Creek subwatershed, and around 2030 for the Peace River at Arcadia subwatershed. Therefore, an extra analysis was conducted for 2035 in Horse Creek to evaluate the near peak capture conditions.

5.2.1 Desoto Mine Impacts on Horse Creek

Table 16 presents the projected flows and percent change from 2009 average annual and seasonal flows during an average rainfall year with 100 percent capture of stormwater in the capture area of the Desoto Mine at the Horse Creek flow station (i.e., near Arcadia). The maximum influence was predicted to occur around 2035, when annual average flow decreases by approximately 8 percent, dry season flow decreases by approximately 9 percent, and wet season flow decreases by approximately 6 percent from 2009 levels when compared to the current (2009) land use. However, because of projected changes in land use within this watershed, flows are predicted to increase from 2009 levels by 2060.

Table 17 presents the flow and percent change from 2009 average annual and seasonal flows during an average rainfall year with 50 percent capture of stormwater in the capture area of the Desoto Mine at the Horse Creek flow station. The maximum influence was predicted to occur around 2035, when annual average flow decreases by approximately 3 percent, dry season flow decreases by approximately 4 percent, and wet season flow decreases by approximately 1 percent from 2009 levels. However, when considering only the Desoto Mine, because of projected changes in land use within this watershed, annual average flows are predicted to increase by approximately 3 percent when compared to 2009 flows with a 2 percent increase in dry season flows and a 5 percent increase in wet weather flows by 2060.

The same type of evaluation was performed for a low rainfall year. For the Desoto Mine analysis, this low rainfall calculation used 43 inches of rainfall per year.

Table 18 presents the flows and percent change from 2009 average annual and seasonal flows during a low rainfall year with 100 percent capture of stormwater in the capture area of the Desoto Mine at the Horse Creek flow station. The maximum influence was predicted to occur around 2035, when annual average flow decreases by approximately 8 percent, dry season flow decreases by approximately 9 percent, and wet season flow decreases by approximately 6 percent from 2009 levels. However, because of projected changes in land use within this watershed, flows are predicted to increase from 2009 levels by 2060. These results are about the same relative percentage as for an average year's wet season, but the dry season value is 2 cfs lower by 2035.

Table 19 presents the flows and percent change from 2009 average annual and seasonal flows during a low rainfall year with 50 percent capture of stormwater in the capture area of the Desoto Mine at the Horse Creek flow station. The maximum influence was predicted to occur around 2035, when annual average flow decreases by approximately 3 percent, dry season flow decreases by approximately 4 percent, and wet season flow decreases by approximately 1 percent from 2009 levels. However, when considering only the Desoto Mine, because of projected changes in land use within this watershed, annual average flows are predicted to increase by approximately 3 percent when compared to 2009 flows with a 2 percent increase in dry season flow (2 cfs) and a 4 percent increase in wet season flow (9 cfs) by 2060.

To illustrate the effect on Horse Creek stream flow under the conditions and scenarios evaluated, the results are presented graphically and compared to the No Action Alternative conditions. Figures 30 and 31 present the seasonal and annual average flows calculated for the Horse Creek gage station with and without the Desoto Mine based on 100 percent capture and 50 percent capture of stormwater, respectively, during average rainfall conditions. One standard deviation above and below the historical mean flow is presented to illustrate the historical range in annual stream flow.

TABLE 10

No Action Alternative - Predicted Conditions in the Peace River Subwatersheds for an Average Rainfall Year

	Peace River at Arcadia			Joshua Creek			Horse Creek			Prairie Creek			Peace River to Charlotte Harbor		
Year	Qannual (cfs)	Qdry (cfs)	Qwet (cfs)	Qannual (cfs)	Qdry (cfs)	Qwet (cfs)	Qannual (cfs)	Qdry (cfs)	Qwet (cfs)	Qannual (cfs)	Qdry (cfs)	Qwet (cfs)	Qannual (cfs)	Qdry (cfs)	Qwet (cfs)
2009	713	328	1,657	90	40	222	171	78	404	145	65	348	1,119	510	2,631
2020	726	332	1,702	95	43	232	173	78	413	151	68	362	1,145	520	2,709
2030	738	336	1,743	99	44	239	173	78	416	158	71	375	1,168	529	2,774
2040	754	343	1,785	102	46	246	174	78	419	164	75	389	1,195	541	2,840
2050	772	351	1,829	105	47	252	175	79	422	171	78	403	1,223	554	2,906
2060	783	355	1,858	107	48	257	177	79	424	177	81	416	1,244	564	2,955

Wet season is from June through September, and the dry season is the rest of the year. Annual flow is average value for given annual precipitation total.
Rainfall is based on long term monthly averages.
Average rainfall year has 50 inches in the Peace River watershed.

TABLE 11

No Action Alternative – Predicted Conditions in the Myakka River Subwatersheds for an Average Rainfall Year

	Upper Myakka River			Big Slough Basin			Lower Myakka River (incl. Big Slough Basin)			Myakka River to Charlotte Harbor		
Year	Qannual (cfs)	Qdry (cfs)	Qwet (cfs)	Qannual (cfs)	Qdry (cfs)	Qwet (cfs)	Qannual (cfs)	Qdry (cfs)	Qwet (cfs)	Qannual (cfs)	Qdry (cfs)	Qwet (cfs)
2009	243	109	589	217	117	629	432	128	664	675	237	1,253
2020	252	113	608	217	117	629	432	128	664	684	241	1,272
2030	259	116	624	217	117	629	432	128	664	690	244	1,288
2040	265	119	640	217	117	629	432	128	664	697	247	1,304
2050	272	122	655	217	117	629	432	128	664	704	250	1,319
2060	279	125	671	217	117	629	432	128	664	711	253	1,335

Average rainfall year has 53 inches in the Myakka River watershed.

TABLE 12

No Action Alternative – Predicted Conditions in the Upper Charlotte Harbor for an Average Rainfall Year

Year	Charlotte Harbor Average Year Annual			Charlotte Harbor Average Year Dry Season			Charlotte Harbor Average Year Wet Season		
	Peace River (cfs)	Myakka River (cfs)	Total (cfs)	Peace River (cfs)	Myakka River (cfs)	Total (cfs)	Peace River (cfs)	Myakka River (cfs)	Total (cfs)
2009	1,119	675	1,794	510	237	747	2,631	1,253	3,884
2020	1,145	684	1,829	520	241	761	2,709	1,272	3,981
2030	1,168	690	1,858	529	244	773	2,774	1,288	4,062
2040	1,195	697	1,892	541	247	788	2,840	1,304	4,143
2050	1,223	704	1,928	554	250	805	2,906	1,319	4,225
2060	1,244	711	1,955	564	253	817	2,955	1,335	4,290

TABLE 13

No Action Alternative -Predicted Conditions in the Peace River Subwatersheds for a Low Rainfall Year

Year	Peace River at Arcadia			Joshua Creek			Horse Creek			Prairie Creek			Peace River to Charlotte Harbor		
	Qannual (cfs)	Qdry (cfs)	Qwet (cfs)	Qannual (cfs)	Qdry (cfs)	Qwet (cfs)	Qannual (cfs)	Qdry (cfs)	Qwet (cfs)	Qannual (cfs)	Qdry (cfs)	Qwet (cfs)	Qannual (cfs)	Qdry (cfs)	Qwet (cfs)
2009	330	152	766	60	27	148	84	38	199	93	42	225	568	259	1,338
2020	337	154	787	64	28	155	85	38	203	97	44	233	583	264	1,379
2030	342	156	807	66	30	160	85	38	205	102	46	242	595	270	1,414
2040	350	159	827	68	31	164	86	39	206	106	48	251	610	276	1,449
2050	358	163	848	70	32	169	86	39	207	110	50	260	625	283	1,484
2060	363	165	862	72	32	172	87	39	209	114	52	268	636	288	1,511

Wet season is from June through September, and the dry season is the rest of the year. Annual flow is average value for given annual precipitation total.
Rainfall is based on the lowest 20th percentile of long term annual averages, which is similar to SWFWMD permitting basis for irrigation use.
Low rainfall year has 43 inches in the Peace River watershed.

TABLE 14

No Action Alternative - Predicted Conditions in the Myakka River Subwatersheds for a Low Rainfall Year

	Upper Myakka River			Big Slough Basin			Lower Myakka River (incl. Big Slough Basin)			Myakka River to Charlotte Harbor		
Year	Qannual (cfs)	Qdry (cfs)	Qwet (cfs)	Qannual (cfs)	Qdry (cfs)	Qwet (cfs)	Qannual (cfs)	Qdry (cfs)	Qwet (cfs)	Qannual (cfs)	Qdry (cfs)	Qwet (cfs)
2009	204	91	493	176	95	511	350	104	539	555	195	1,032
2020	204	91	493	176	95	511	350	104	539	555	195	1,032
2030	210	94	506	176	95	511	350	104	539	560	198	1,045
2040	215	97	519	176	95	511	350	104	539	566	200	1,058
2050	221	99	532	176	95	511	350	104	539	571	203	1,070
2060	226	102	544	176	95	511	350	104	539	577	206	1,083

Low rainfall year has 43 inches in the Myakka River watershed.

TABLE 15

No Action Alternative - Predicted Conditions in the Upper Charlotte Harbor for a Low Rainfall Year

	Charlotte Harbor Average Year Annual			Charlotte Harbor Average Year Dry Season			Charlotte Harbor Average Year Wet Season		
Year	Peace River (cfs)	Myakka River (cfs)	Total (cfs)	Peace River (cfs)	Myakka River (cfs)	Total (cfs)	Peace River (cfs)	Myakka River (cfs)	Total (cfs)
2009	568	555	1,122	259	195	454	1,338	1,032	2,369
2020	583	555	1,137	264	195	460	1,379	1,032	2,411
2030	595	560	1,155	270	198	467	1,414	1,045	2,458
2040	610	566	1,175	276	200	477	1,449	1,058	2,507
2050	625	571	1,196	283	203	486	1,484	1,070	2,554
2060	636	577	1,213	288	206	494	1,511	1,083	2,593

TABLE 16

Projected Flows and Percent Change from 2009 Flows during Average Rainfall Year and 100 Percent Capture at the Horse Creek Flow Station with the Desoto Mine

Year	Annual Average Flow (cfs)	Annual Average Percent Change from 2009 Flows	Dry Season Average Flow (cfs)	Dry Season Average Percent Change from 2009 Flows	Wet Season Average Flow (cfs)	Wet Season Average Percent Change from 2009 Flows
2009	171	0%	78	0%	404	0%
2020	173	1%	78	0%	413	2%
2030	161	-6%	72	-7%	387	-4%
2035	157	-8%	71	-9%	378	-6%
2040	164	-4%	74	-5%	394	-2%
2050	175	3%	79	2%	422	4%
2060	177	3%	79	2%	424	5%

TABLE 17

Projected Flows and Percent Change from 2009 Flows during Average Rainfall Year and 50 Percent Capture at the Horse Creek Flow Station with the Desoto Mine

Year	Annual Average Flow (cfs)	Annual Average Percent Change from 2009 Flows	Dry Season Average Flow (cfs)	Dry Season Average Percent Change from 2009 Flows	Wet Season Average Flow (cfs)	Wet Season Average Percent Change from 2009 Flows
2009	171	0%	78	0%	404	0%
2020	173	1%	78	0%	413	2%
2030	167	-2%	75	-3%	401	-1%
2035	166	-3%	75	-4%	399	-1%
2040	169	-1%	76	-2%	407	1%
2050	175	3%	79	2%	422	4%
2060	177	3%	79	2%	424	5%

TABLE 18

Projected Flows and Percent Change from 2009 Flows during Low Rainfall Year and 100 Percent Capture at the Horse Creek Flow Station with the Desoto Mine

	Annual Average Flow (cfs)	Annual Average Percent Change from 2009 Flows	Dry Season Average Flow (cfs)	Dry Season Average Percent Change from 2009 Flows	Wet Season Average Flow (cfs)	Wet Season Average Percent Change from 2009 Flows
2009	84	0%	38	0%	199	0%
2020	85	1%	38	0%	203	2%
2030	79	-6%	36	-7%	190	-4%
2035	77	-8%	35	-9%	186	-6%
2040	81	-4%	36	-5%	194	-2%
2050	86	3%	39	2%	207	4%
2060	87	3%	39	2%	209	5%

TABLE 19

Projected Flows and Percent Change from 2009 Flows during Low Rainfall Year and 50 Percent Capture at the Horse Creek Flow Station with the Desoto Mine

	Annual Average Flow (cfs)	Annual Average Percent Change from 2009 Flows	Dry Season Average Flow (cfs)	Dry Season Average Percent Change from 2009 Flows	Wet Season Average Flow (cfs)	Wet Season Average Percent Change from 2009 Flows
2009	84	0%	38	0%	199	0%
2020	85	1%	38	0%	203	2%
2030	82	-2%	37	-3%	197	-1%
2035	82	-3%	37	-4%	196	-1%
2040	83	-1%	37	-2%	200	1%
2050	86	3%	39	2%	207	4%
2060	87	3%	39	2%	209	5%

FIGURE 30

Horse Creek Annual Average and Seasonal Projected Flows for Average Annual Rainfall based on 100 Percent Capture of Excess Rainfall with and without Desoto Mine

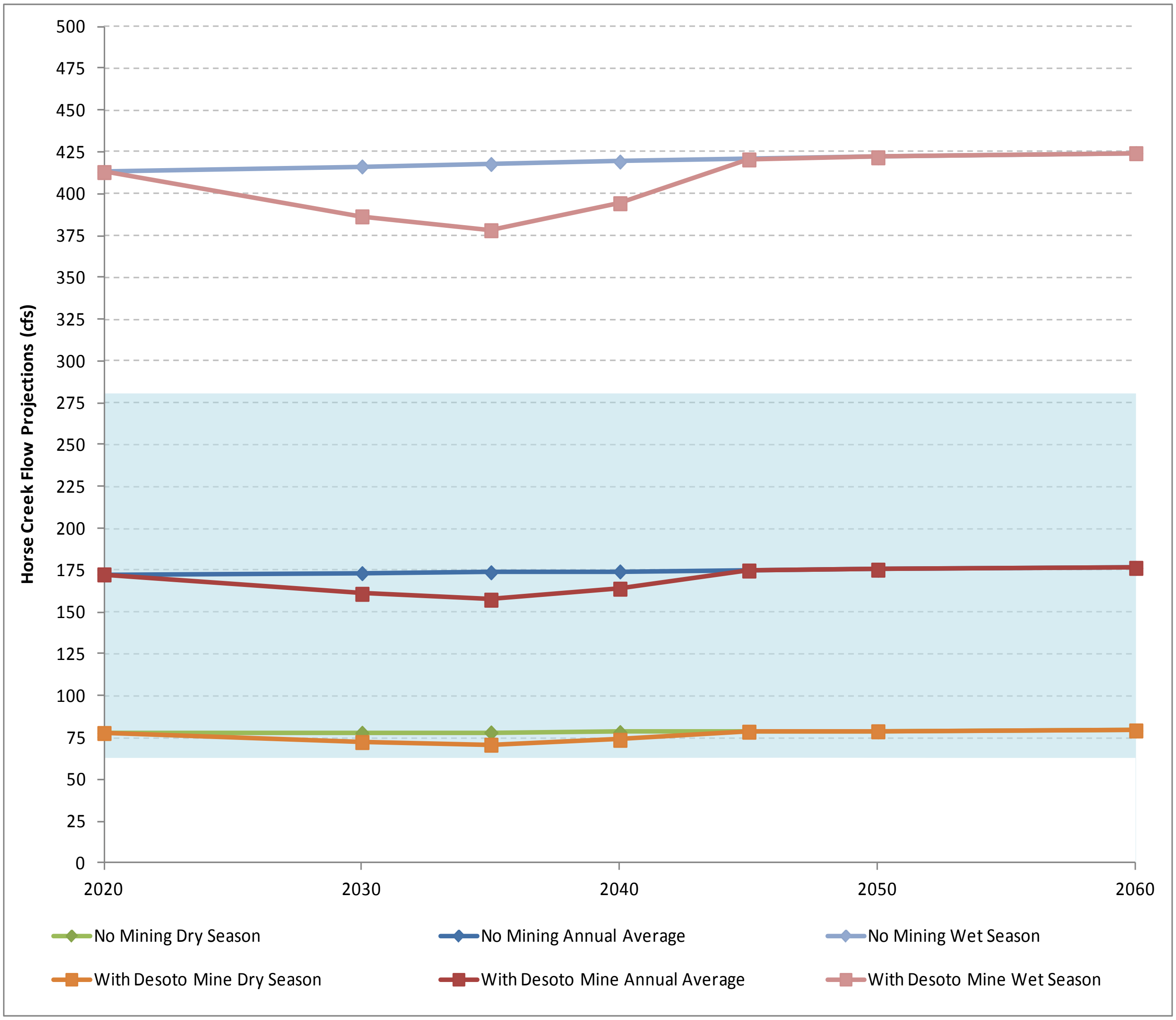
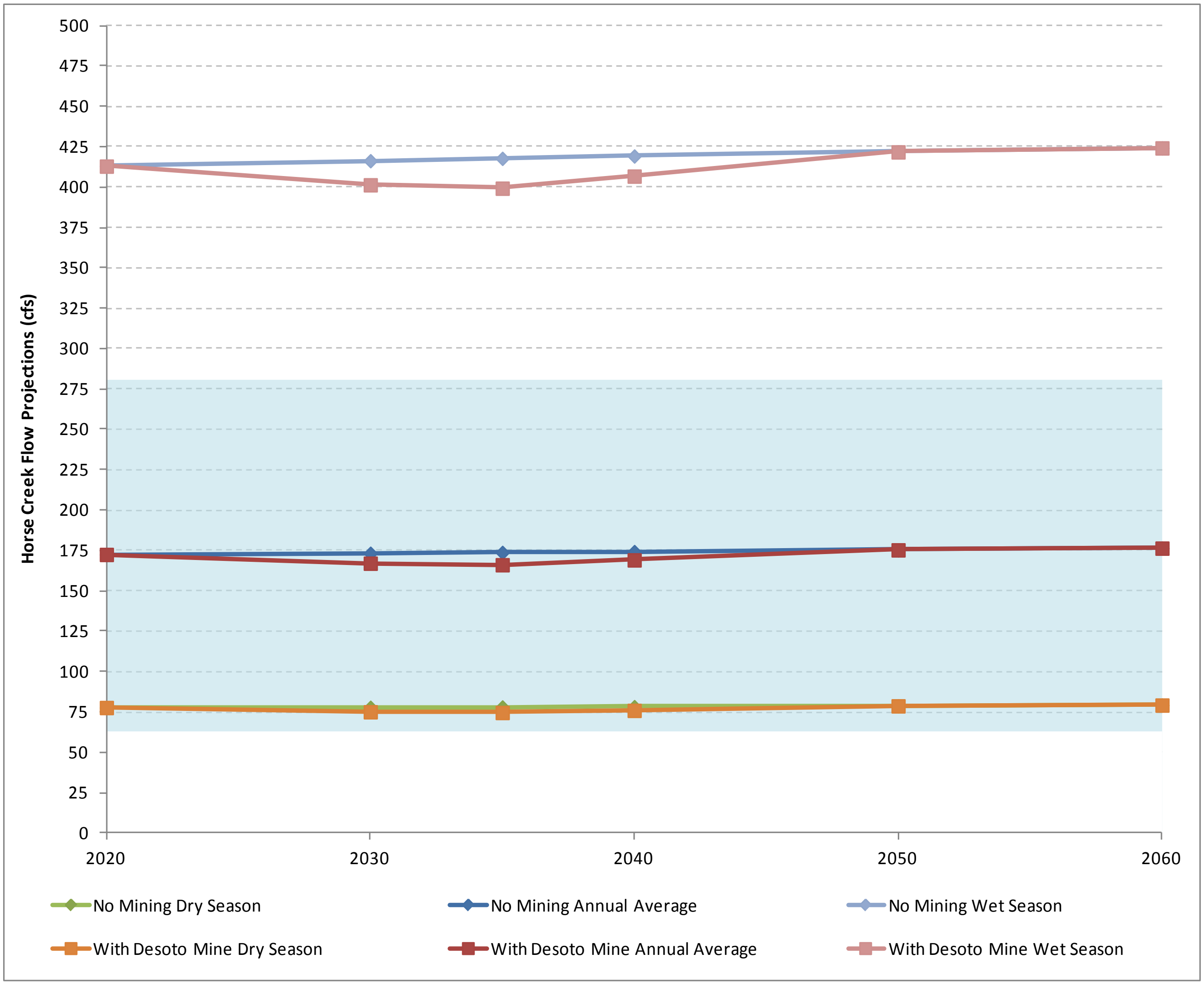


FIGURE 31
Horse Creek Annual Average and Seasonal Projected Flows for Average Annual Rainfall based on 50 Percent Capture of Excess Rainfall with and without Desoto Mine



The largest influence on annual average flow from the Horse Creek subwatershed during average rainfall conditions was predicted to occur around 2035. Based on 100 percent capture of stormwater, Horse Creek may have an average annual flow of approximately 173 cfs without the Desoto Mine, and approximately 157 cfs with the Desoto Mine. Assuming a 50 percent capture of stormwater, Horse Creek may have an average annual flow of approximately 166 cfs. This corresponds to a decrease in flow of about 7 cfs when compared to the No Action Alternative conditions.

Figures 32 and 33 present the seasonal and annual average flows calculated for the Horse Creek gage station with and without the Desoto Mine based on 100 percent capture and 50 percent capture of stormwater, respectively, during low rainfall conditions. One standard deviation above and below the historical mean flow is presented to illustrate the historical range in annual stream flow. Since about 33 percent of the annual data falls outside of one standard deviation, it is not unusual for the dry season of a dry year to fall outside of this shaded range. However, note that even with a low 20th percentile rainfall, the projected annual flow is within one standard deviation.

FIGURE 32

Horse Creek Annual Average and Seasonal Projected Flows for Low Annual Rainfall based on 100 Percent Capture of Excess Rainfall with and without Desoto Mine

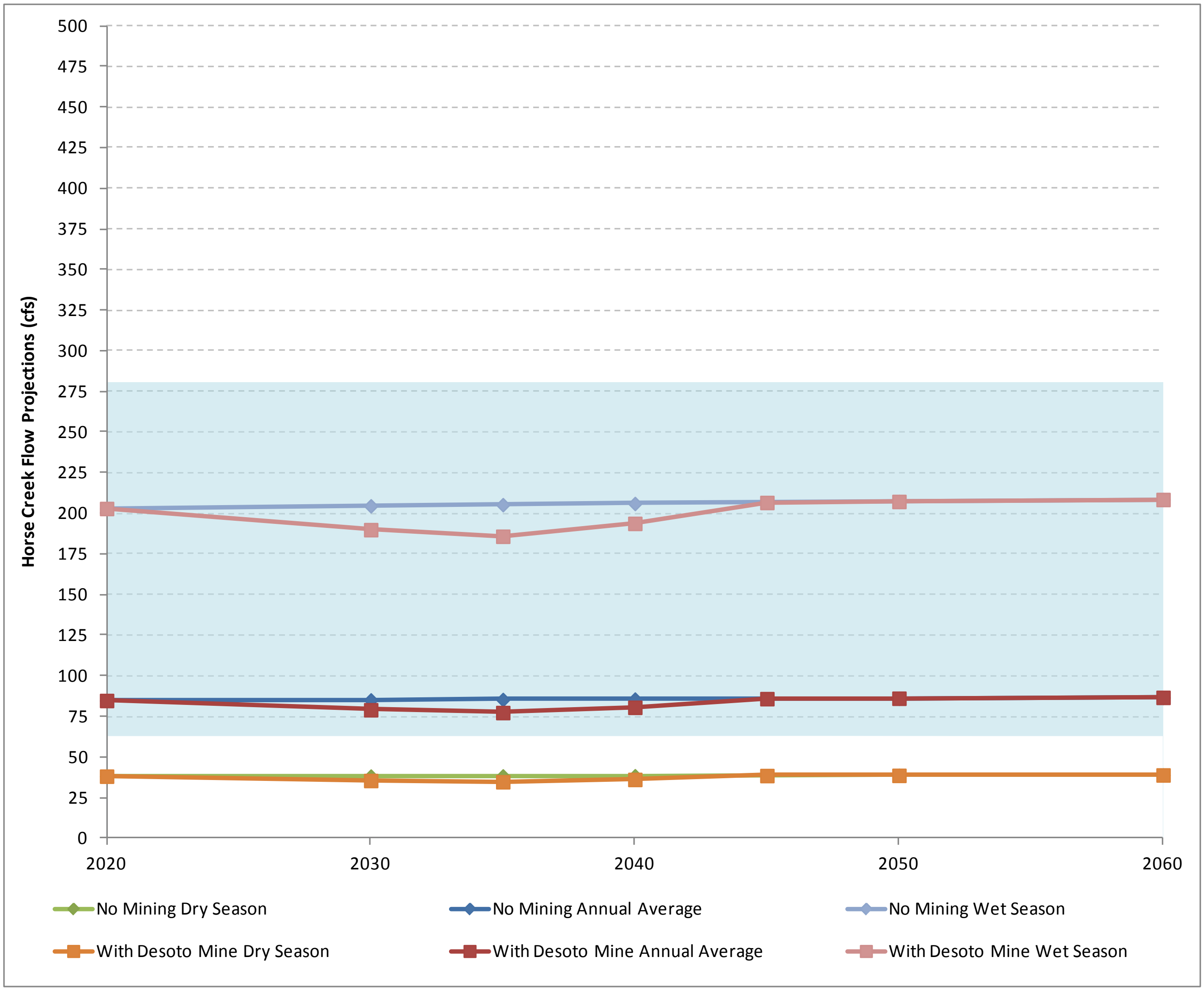
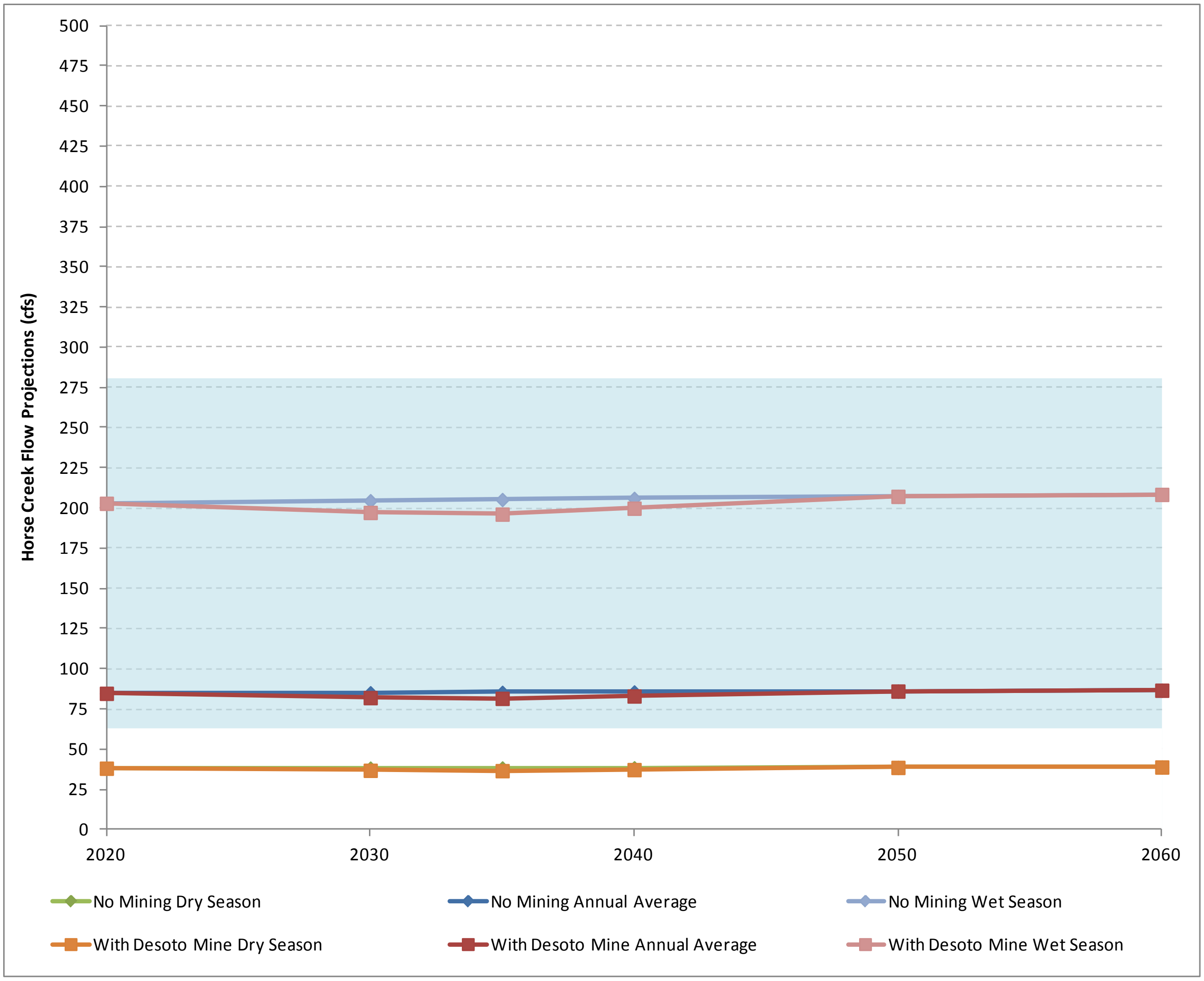


FIGURE 33

Horse Creek Annual Average and Seasonal Projected Flows for Low Annual Rainfall based on 50 Percent Capture of Excess Rainfall with and without Desoto Mine



Similar to average rainfall conditions, the largest influence on annual average flow from the Horse Creek subwatershed during low rainfall conditions was predicted to occur around 2035. Based on 100 percent capture of stormwater, Horse Creek may have an average annual flow of approximately 85 cfs without the Desoto Mine, and approximately 77 cfs with the Desoto Mine. Assuming a 50 percent capture of stormwater, Horse Creek may have an average annual flow of approximately 82 cfs. This corresponds to a decrease in flow of 3 cfs when compared to the No Action Alternative conditions.

5.2.2 Desoto Mine Impacts on Peace River at Arcadia

Table 20 presents the flows and percent change from 2009 average annual and seasonal flows during an average rainfall year with 100 percent capture of stormwater in the capture area of the Desoto Mine at the Peace River at Arcadia flow station. The maximum influence was predicted to occur around 2030. However, based on projected land use changes within the subwatershed and upstream subwatersheds, flows are predicted to increase during the Desoto mining period. Annual average flow increases by approximately 3 percent during the period of 2030, dry season flow increases by approximately 2 percent, and wet season flow increases by approximately 5 percent from 2009 levels. Flows are predicted to increase from 2009 levels by approximately 10 percent by 2060. Because of the small percentage of land that would be mined compared to the total drainage area of this gage station, the changes in projected land use are predicted to have more of an effect on flow than the Desoto Mine capture.

TABLE 20

Projected Flows and Percent Change from 2009 Flows during Average Rainfall Year and 100 Percent Capture at the Peace River at Arcadia Flow Station with the Desoto Mine

	Annual Average Flow (cfs)	Annual Average Percent Change from 2009 Flows	Dry Season Average Flow (cfs)	Dry Season Average Percent Change from 2009 Flows	Wet Season Average Flow (cfs)	Wet Season Average Percent Change from 2009 Flows
2009	713	0%	328	0%	1,657	0%
2020	726	2%	332	1%	1,702	3%
2030	737	3%	335	2%	1,740	5%
2040	754	6%	343	5%	1,785	8%
2050	772	8%	351	7%	1,829	10%
2060	783	10%	355	8%	1,858	12%

Table 21 presents the flow and percent change from 2009 average annual and seasonal flows during an average rainfall year with 50 percent capture of stormwater in the capture area of the Desoto Mine at the Peace River at Arcadia gage station. The maximum influence was predicted to occur around 2030. However, similar to the 100 percent capture case, based on land use changes within the subwatershed and upstream subwatersheds, flows are predicted to increase during the Desoto mining period. Annual average flow increases by approximately 3 percent during the period of 2030, dry season flow increases by approximately 2 percent, and wet season flow increases by approximately 5 percent from 2009 levels. Flows are predicted to increase from 2009 levels by approximately 10 percent by 2060. Again, the small percentage of land that would be mined compared to the total drainage area of this gage station causes the predicted changes in land use to have more of an effect on flow than the Desoto Mine capture, and flows are projected to be the about the same as in the 100 percent capture case.

TABLE 21

Projected Flows and Percent Change from 2009 Flows during Average Rainfall Year and 50 Percent Capture at the Peace River at Arcadia Flow Station with the Desoto Mine

	Annual Average Flow (cfs)	Annual Average Percent Change from 2009 Flows	Dry Season Average Flow (cfs)	Dry Season Average Percent Change from 2009 Flows	Wet Season Average Flow (cfs)	Wet Season Average Percent Change from 2009 Flows
2009	713	0%	328	0%	1,657	0%
2020	726	2%	332	1%	1,702	3%
2030	738	3%	336	2%	1,742	5%
2040	754	6%	343	5%	1,785	8%
2050	772	8%	351	7%	1,829	10%
2060	783	10%	355	8%	1,858	12%

The same evaluation was performed for a low rainfall year. Table 22 presents the flow and percent change from 2009 average annual and seasonal flows during a low rainfall year with 100 percent capture of stormwater in the capture area of the Desoto Mine. The maximum influence was predicted to occur between 2030. However, as in the average rainfall scenarios, based on projected land use changes within the subwatershed and upstream subwatersheds, flows are predicted to increase during the Desoto mining period. Annual average flow increases by approximately 4 percent during the period of 2030, dry season flow increases by approximately 2 percent, and wet season flow increases by approximately 5 percent from 2009 levels. Flows are predicted to increase from 2009 levels by approximately 10 percent by 2060.

TABLE 22

Projected Flows and Percent Change from 2009 Flows during Low Rainfall Year and 100 Percent Capture at the Peace River at Arcadia Flow Station with the Desoto Mine

	Annual Average Flow (cfs)	Annual Average Percent Change from 2009 Flows	Dry Season Average Flow (cfs)	Dry Season Average Percent Change from 2009 Flows	Wet Season Average Flow (cfs)	Wet Season Average Percent Change from 2009 Flows
2009	330	0%	152	0%	766	0%
2020	337	2%	154	1%	787	3%
2030	342	4%	156	2%	806	5%
2040	350	6%	159	5%	827	8%
2050	358	9%	163	7%	848	11%
2060	363	10%	165	9%	862	13%

Table 23 presents the flow and percent change from 2009 average annual and seasonal flows during a low rainfall year with 50 percent capture of stormwater in the capture area of the Desoto Mine. The maximum influence was predicted to occur between 2030. However, similar to the average rainfall year scenario, based on land use changes within the subwatershed and upstream subwatersheds, flow was predicted to increase during the Desoto mining period. Annual average flow increases by approximately 4 percent during the period of 2030, dry season flow increases by approximately 2 percent, and wet season flow increases by approximately 5 percent from 2009 levels. Flows are predicted to increase from 2009 levels by approximately 10 percent by 2060. Because of the small percentage of land that is being mined compared to the total drainage area of this gage station, the changes in land use are predicted to have more of an effect on flow than the Desoto Mine capture, and flows are projected to be about the same as in the 100 percent capture case.

TABLE 23

Projected Flows and Percent Change from 2009 Flows during Low Rainfall Year and 50 Percent Capture at the Peace River at Arcadia Flow Station with the Desoto Mine

	Annual Average Flow (cfs)	Annual Average Percent Change from 2009 Flows	Dry Season Average Flow (cfs)	Dry Season Average Percent Change from 2009 Flows	Wet Season Average Flow (cfs)	Wet Season Average Percent Change from 2009 Flows
2009	330	0%	152	0%	766	0%
2020	337	2%	154	1%	787	3%
2030	342	4%	156	3%	806	5%
2040	350	6%	159	5%	827	8%
2050	358	9%	163	7%	848	11%
2060	363	10%	165	9%	862	13%

To illustrate the effect on Peace River at Arcadia stream flow under the conditions and scenarios evaluated, the results are presented graphically and compared to the No Action Alternative conditions. Figures 34 and 35 present the seasonal and annual average flows calculated for the Peace River at Arcadia gage station with and without the Desoto Mine based on 100 percent capture and 50 percent capture of stormwater, respectively, during average rainfall conditions. One standard deviation above and below the historical mean flow is presented to illustrate the historical range in annual stream flow. The lines essentially overlap at this scale because of the small differences.

FIGURE 34

Peace River at Arcadia Annual Average and Seasonal Projected Flows for Average Annual Rainfall based on 100 Percent Capture of Excess Rainfall with and without Desoto Mine

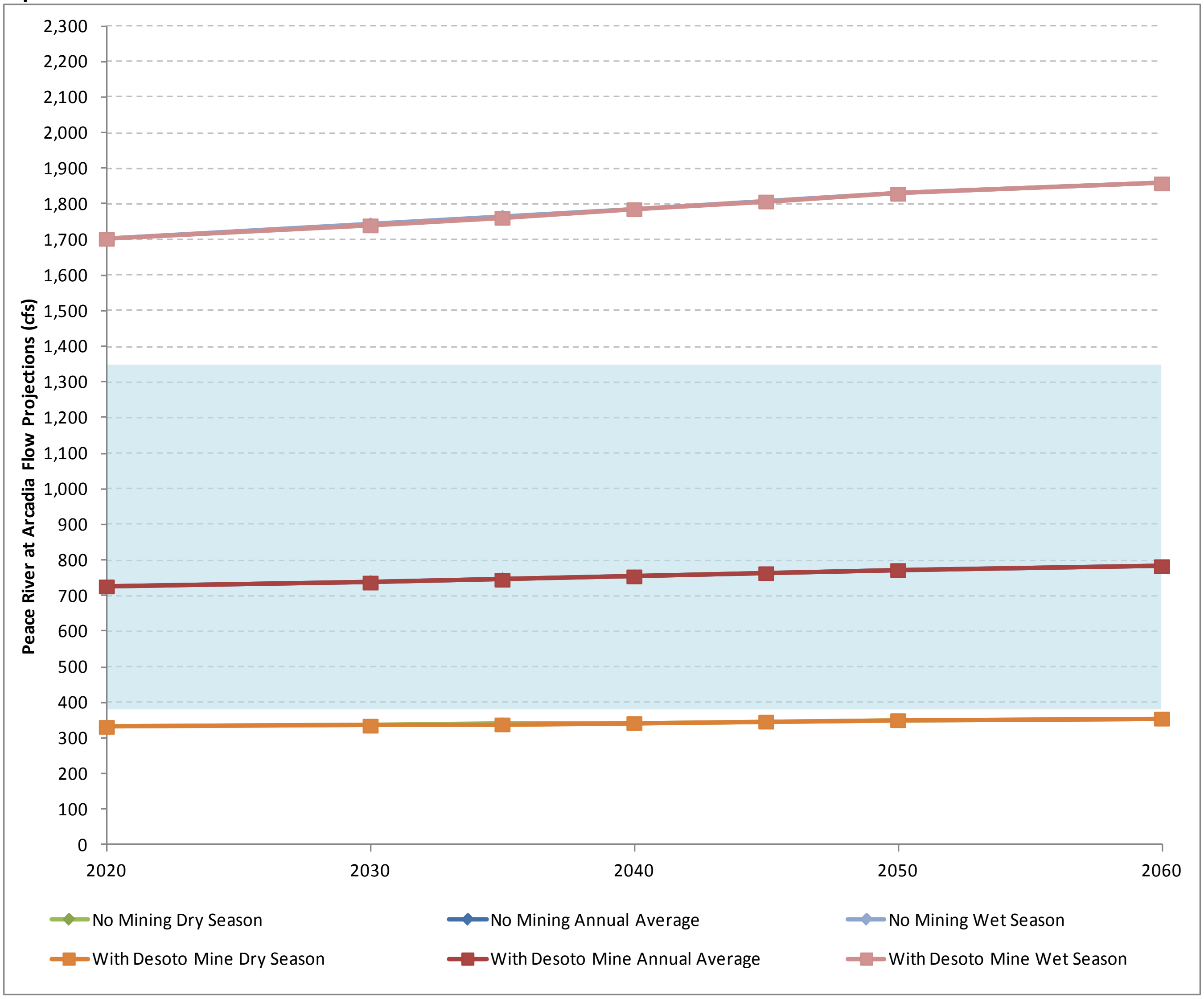
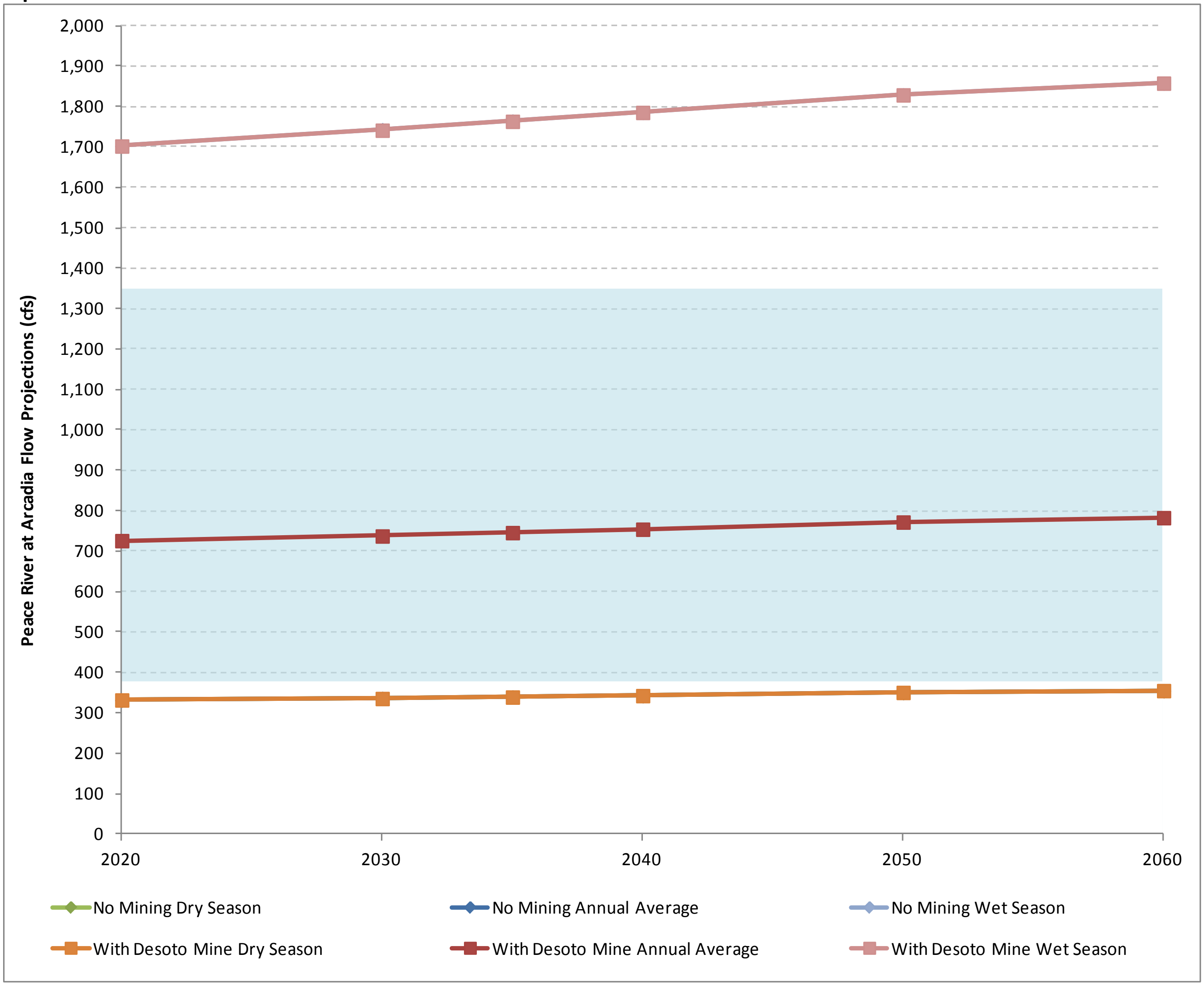


FIGURE 35

Peace River at Arcadia Annual Average and Seasonal Projected Flows for Average Annual Rainfall based on 50 Percent Capture of Excess Rainfall with and without Desoto Mine



The largest influence on annual average flow from the Peace River at Arcadia subwatershed during average rainfall conditions is predicted to occur between 2030. Based on 100 percent capture of stormwater, the Peace River at Arcadia gage station may have an average annual flow of approximately 738 cfs without the Desoto Mine (i.e., the No Action Alternative) and approximately 737 cfs with the Desoto Mine. Assuming a 50 percent capture of stormwater, Peace River at Arcadia may have an average annual flow of approximately 738 cfs for the No Action Alternative, essentially identical to the 100 percent capture case. This corresponds to a decrease in flow of less than 1 cfs when compared to the No Action Alternative results (which is why Figure 35 looks like there is a line missing, because they overlap).

Figures 36 and 37 present the seasonal and annual average flows calculated for the Peace River at Arcadia gage station with and without the Desoto Mine based on 100 percent capture and 50 percent capture of stormwater, respectively, during low rainfall conditions. Notice that at this gage, the predicted average annual low rainfall year is just below the lower range of one standard deviation.

FIGURE 36

Peace River at Arcadia Annual Average and Seasonal Projected Flows for Low Annual Rainfall based on 100 Percent Capture of Excess Rainfall with and without Desoto Mine

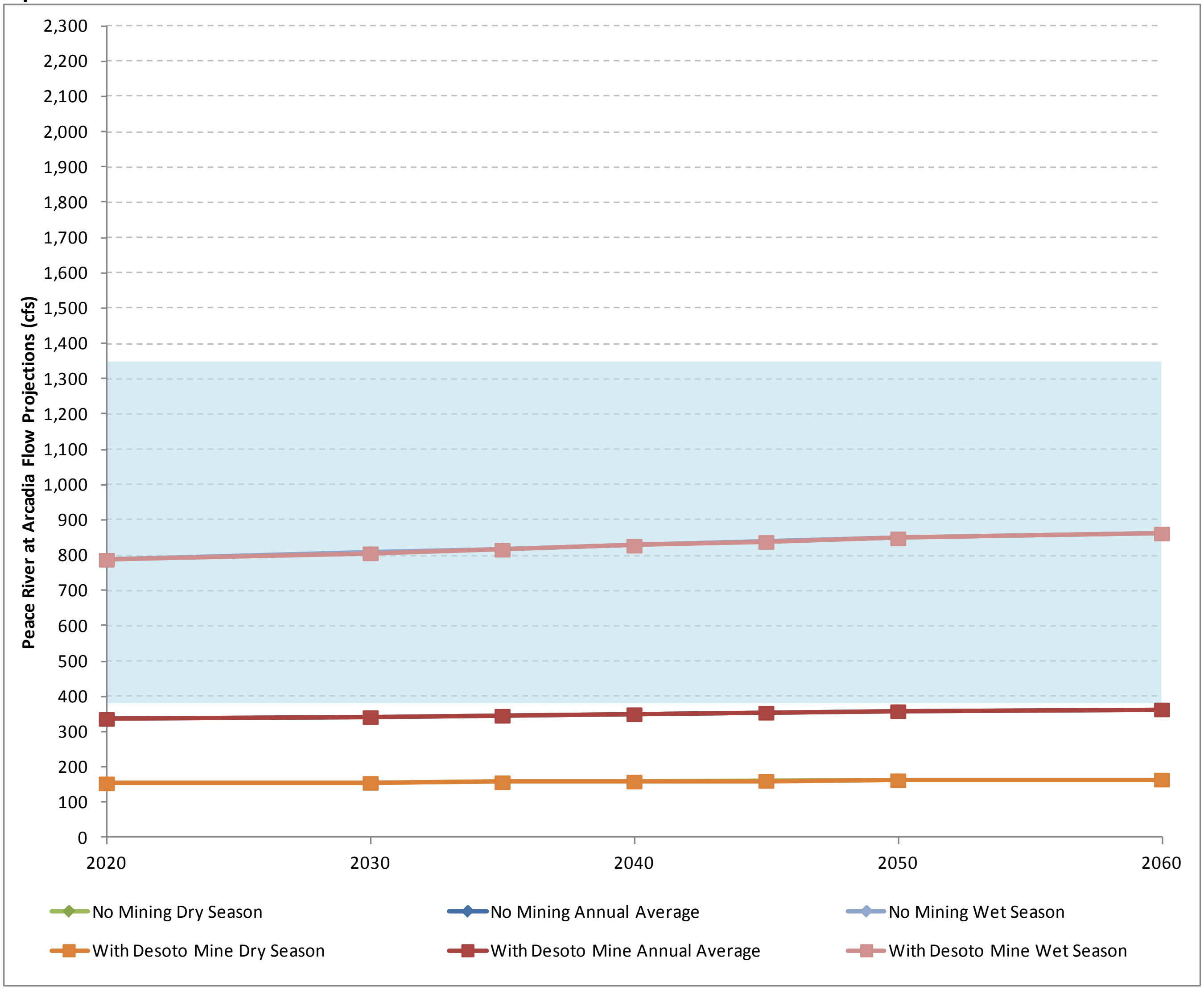
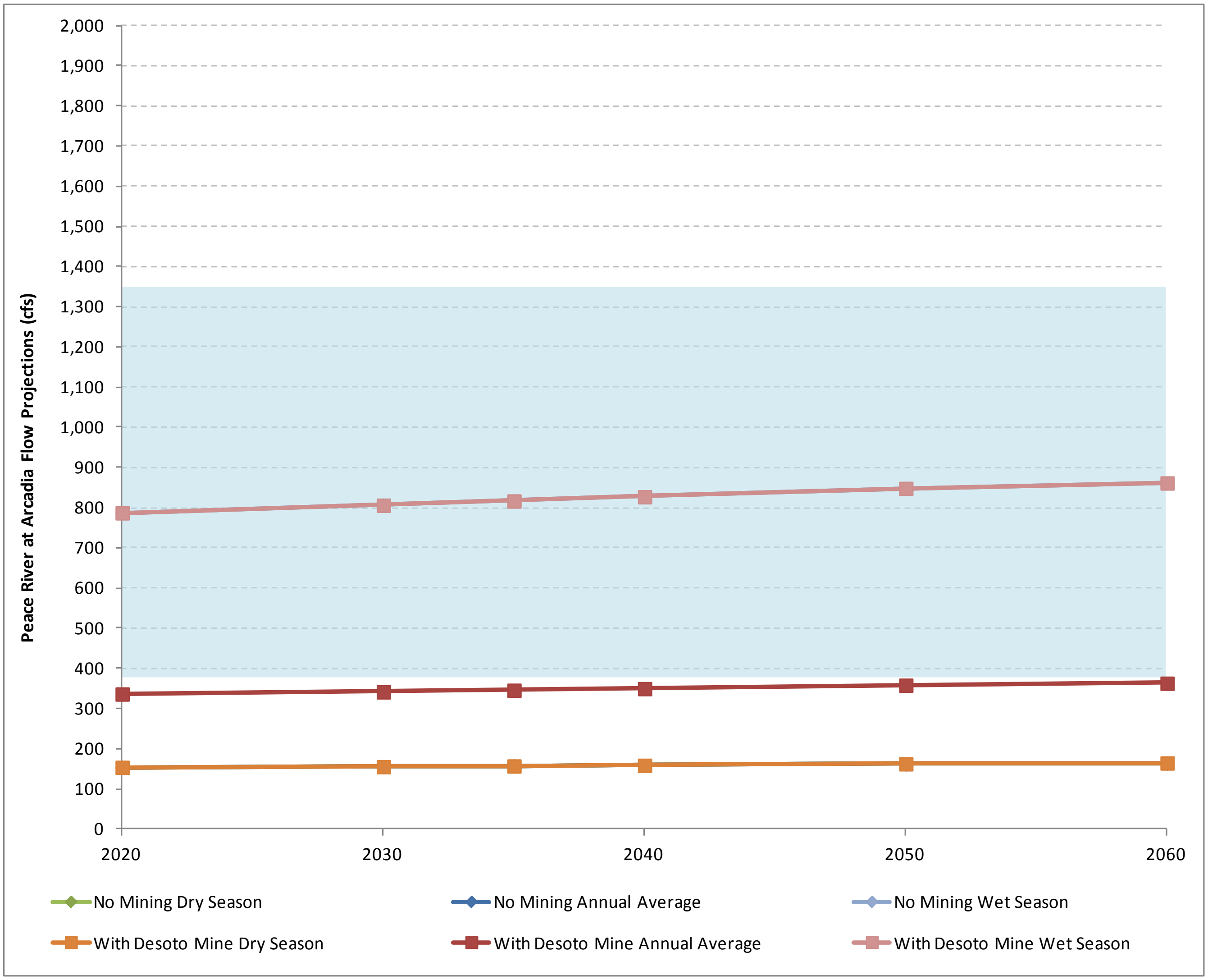


FIGURE 37

Peace River at Arcadia Annual Average and Seasonal Projected Flows for Low Annual Rainfall based on 50 Percent Capture of Excess Rainfall with and without Desoto Mine



Similar to average rainfall conditions, the largest influence on annual average flow from the Peace River at Arcadia subwatershed during low rainfall conditions was predicted to occur between 2030. Based on 100 percent capture of stormwater, Peace River at Arcadia may have an average annual flow of approximately 342 cfs without the Desoto Mine (No Action Alternative) and approximately the same flow with the Desoto Mine. Assuming a 50 percent capture of stormwater, Peace River at Arcadia would have about the same flow as the 100 percent capture case. This corresponds to a decrease in flow of less than 1 cfs when compared to the No Action Alternative conditions.

The Desoto Mine would account for a small relative contribution to the flows measured at the Peace River at Arcadia gage station. The Desoto Mine impact on flow quantities at this station would likely not be perceivable, particularly since flows would be expected to increase because of land use changes in the Peace River at Arcadia drainage area.

5.3 Ona Mine Impacts on Runoff Characteristics and Stream Flow

The effects of the Ona Mine were calculated by evaluating the change to the runoff coefficients in the Horse Creek and Peace River at Arcadia subwatersheds with this mine's capture area effects accounted for over the life cycle of the mine. Projections were performed for an average rainfall year and for a low rainfall year with 100 and

50 percent stormwater capture, as was done for the Desoto Mine. The capture curves indicate that the most area under surface water management controls at this alternative is around 2045 for the Horse Creek subwatershed, and around 2045 for the Peace River at Arcadia subwatershed. Therefore, an extra analysis was conducted for 2045 to evaluate the near peak capture conditions.

5.3.1 Ona Mine Impacts on Horse Creek

Table 24 presents the flow and percent change from 2009 average annual and seasonal flows during an average rainfall year with 100 percent capture of stormwater in the capture area of the Ona Mine at the Horse Creek flow station near Arcadia. The maximum influence was predicted to occur around 2045, when annual average flow decreases by approximately 6 percent, dry season flow decreases by approximately 7 percent, and wet season flow decreases by approximately 4 percent from 2009 levels. However, because of changes in land use within this watershed, flows are predicted to increase from 2009 levels by 2060.

TABLE 24

Projected Flows and Percent Change from 2009 Flows during Average Rainfall Year and 100 Percent Capture at the Horse Creek Flow Station with the Ona Mine

	Annual Average Flow (cfs)	Annual Average Percent Change from 2009 Flows	Dry Season Average Flow (cfs)	Dry Season Average Percent Change from 2009 Flows	Wet Season Average Flow (cfs)	Wet Season Average Percent Change from 2009 Flows
2009	171	0%	78	0%	404	0%
2020	172	1%	78	0%	413	2%
2030	166	-3%	74	-4%	398	-2%
2040	162	-5%	73	-6%	391	-3%
2045	161	-6%	72	-7%	387	-4%
2050	164	-4%	74	-5%	395	-2%
2060	175	2%	79	1%	420	4%

Table 25 presents the flow and percent change from 2009 average annual and seasonal flows during an average rainfall year with 50 percent capture of stormwater in the capture area of the Ona Mine at the Horse Creek flow station. The maximum influence was predicted to occur between 2040 and 2045, when annual average flow decreases by approximately 1 percent, dry season flow decreases by approximately 2 to 3 percent, and wet season flow is approximately the same as 2009 levels. However, when considering only the Ona Mine and changes in land use within this watershed, annual average flows are predicted to increase by approximately 3 percent when compared to 2009 flows, with a 2 percent increase in dry season flows and a 4 percent increase in wet weather flows by 2060.

TABLE 25

Projected Flows and Percent Change from 2009 Flows during Average Rainfall Year and 50 Percent Capture at the Horse Creek Flow Station with the Ona Mine

	Annual Average Flow (cfs)	Annual Average Percent Change from 2009 Flows	Dry Season Average Flow (cfs)	Dry Season Average Percent Change from 2009 Flows	Wet Season Average Flow (cfs)	Wet Season Average Percent Change from 2009 Flows
2009	171	0%	78	0%	404	0%
2020	172	1%	78	0%	413	2%
2030	169	-1%	76	-2%	407	1%
2040	168	-1%	76	-3%	405	0%
2045	168	-1%	76	-2%	405	0%
2050	170	-1%	76	-2%	408	1%
2060	176	3%	79	2%	422	4%

The same evaluation was performed for a low rainfall year. For the Ona Mine analysis, this calculation used 43 inches of rainfall per year. Table 26 presents the flow and percent change from 2009 average annual and seasonal flows during a low rainfall year with 100 percent capture of stormwater in the capture area of the Ona Mine at the Horse Creek flow station. The maximum influence was predicted to occur 2045, when annual average flow decreases by approximately 6 percent, dry season flow decreases by approximately 7 percent, and wet season flow decreases by approximately 4 percent from 2009 levels. However, because of changes in land use within this watershed, flows are predicted to increase from 2009 levels by 2060.

TABLE 26

Projected Flows and Percent Change from 2009 Flows during Low Rainfall Year and 100 Percent Capture at the Horse Creek Flow Station with the Ona Mine

	Annual Average Flow (cfs)	Annual Average Percent Change from 2009 Flows	Dry Season Average Flow (cfs)	Dry Season Average Percent Change from 2009 Flows	Wet Season Average Flow (cfs)	Wet Season Average Percent Change from 2009 Flows
2009	84	0%	38	0%	199	0%
2020	85	1%	38	0%	203	2%
2030	81	-3%	37	-4%	195	-2%
2040	80	-5%	36	-6%	192	-3%
2045	79	-6%	36	-7%	190	-4%
2050	81	-4%	36	-5%	194	-2%
2060	86	2%	39	1%	207	4%

Table 27 presents the flow and percent change from 2009 average annual and seasonal flows during a low rainfall year with 50 percent capture of stormwater in the capture area of the Ona Mine at the Horse Creek flow station. The maximum influence was predicted to occur in 2040, when annual average flow decreases by approximately 1 percent, dry season flow decreases by approximately 3 percent, and wet season flow is approximately the same as 2009 levels. However, when considering only the Ona Mine, because of changes in land use within this watershed, annual average flows are predicted to increase by approximately 3 percent when compared to 2009 flows with a 2 percent decrease in dry season flows and a 4 percent increase in wet season flows by 2060.

TABLE 27

Projected Flows and Percent Change from 2009 Flows during Low Rainfall Year and 50 Percent Capture at the Horse Creek Flow Station with the Ona Mine

	Annual Average Flow (cfs)	Annual Average Percent Change from 2009 Flows	Dry Season Average Flow (cfs)	Dry Season Average Percent Change from 2009 Flows	Wet Season Average Flow (cfs)	Wet Season Average Percent Change from 2009 Flows
2009	84	0%	38	0%	199	0%
2020	85	1%	38	0%	203	2%
2030	83	-1%	37	-2%	200	1%
2040	83	-1%	37	-3%	199	0%
2045	83	-1%	37	-2%	199	0%
2050	83	-1%	37	-2%	201	1%
2060	86	3%	39	2%	208	4%

To illustrate the effect on Horse Creek stream flow under the conditions and scenarios evaluated, the results are presented graphically and compared to the No Action Alternative conditions. Figures 38 and 39 present the seasonal and annual average flows calculated for the Horse Creek gage station with and without the Ona Mine based on 100 percent capture and 50 percent capture of stormwater, respectively, during average rainfall conditions. One standard deviation above and below the historical mean flow is presented to illustrate the historical range in annual stream flow.

The largest influence on annual average flow from the Horse Creek subwatershed during average rainfall conditions was predicted to occur between 2040 and 2045. Based on 100 percent capture of stormwater, Horse Creek may have an average annual flow of approximately 174 cfs without the Ona Mine (No Action Alternative), and approximately 161 cfs with the Ona Mine around 2045. Assuming a 50 percent capture of stormwater, Horse Creek may have an average annual flow of approximately 166 cfs around 2040. This corresponds to a decrease in flow of 8 cfs when compared to the No Action Alternative conditions.

Figures 40 and 41 present the seasonal and annual average flows calculated for the Horse Creek gage station with and without the Ona Mine based on 100 percent capture and 50 percent capture of stormwater, respectively, during low rainfall conditions.

Similar to average rainfall conditions, the largest influence on annual average flow from the Horse Creek subwatershed during low rainfall conditions was predicted to occur around 2040 and 2045. Based on 100 percent capture of stormwater, Horse Creek may have an average annual flow of approximately 86 cfs without the Ona Mine (No Action Alternative) and approximately 79 cfs with the Ona Mine around 2045. Assuming a 50 percent capture of stormwater, Horse Creek may have an average annual flow of approximately 83 cfs around 2040. This corresponds to a decrease in flow of 3 cfs when compared to the No Action Alternative conditions.

FIGURE 38

Horse Creek Annual Average and Seasonal Projected Flows for Average Annual Rainfall based on 100 Percent Capture of Excess Rainfall with and without Ona Mine

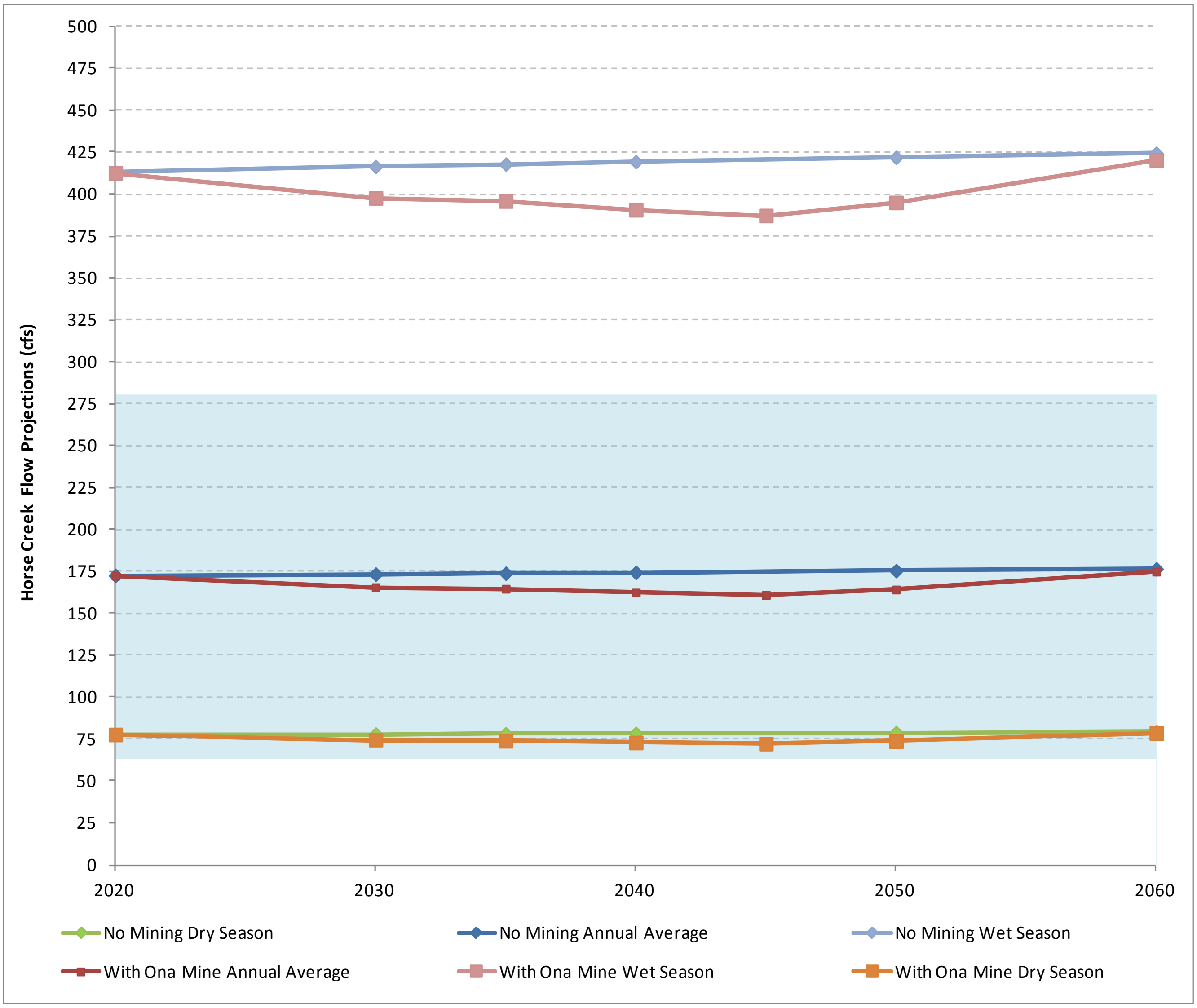


FIGURE 39

Horse Creek Annual Average and Seasonal Projected Flows for Average Annual Rainfall based on 50 Percent Capture of Excess Rainfall with and without Ona Mine

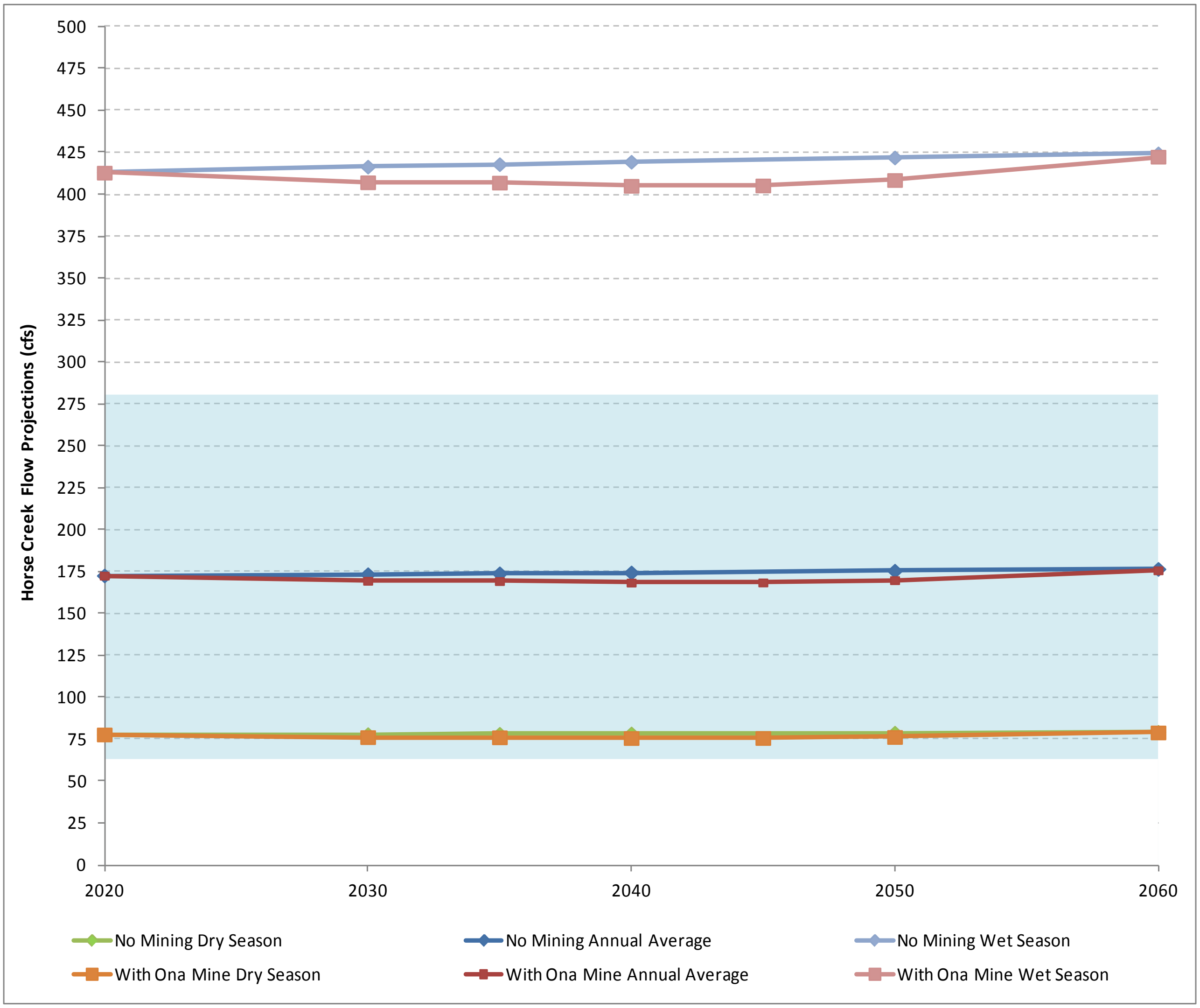


FIGURE 40

Horse Creek Annual Average and Seasonal Projected Flows for Low Annual Rainfall based on 100 Percent Capture of Excess Rainfall with and without Ona Mine

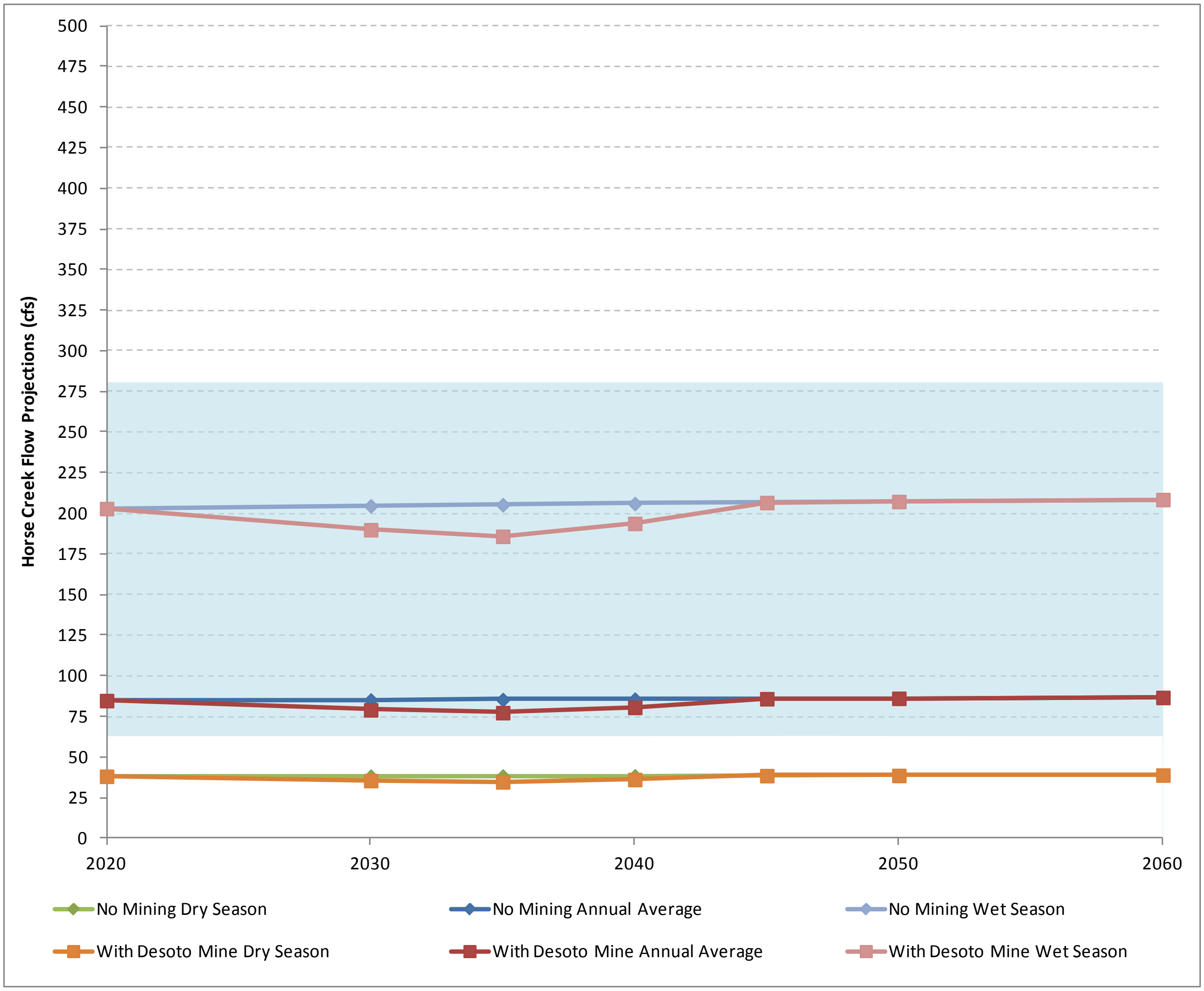
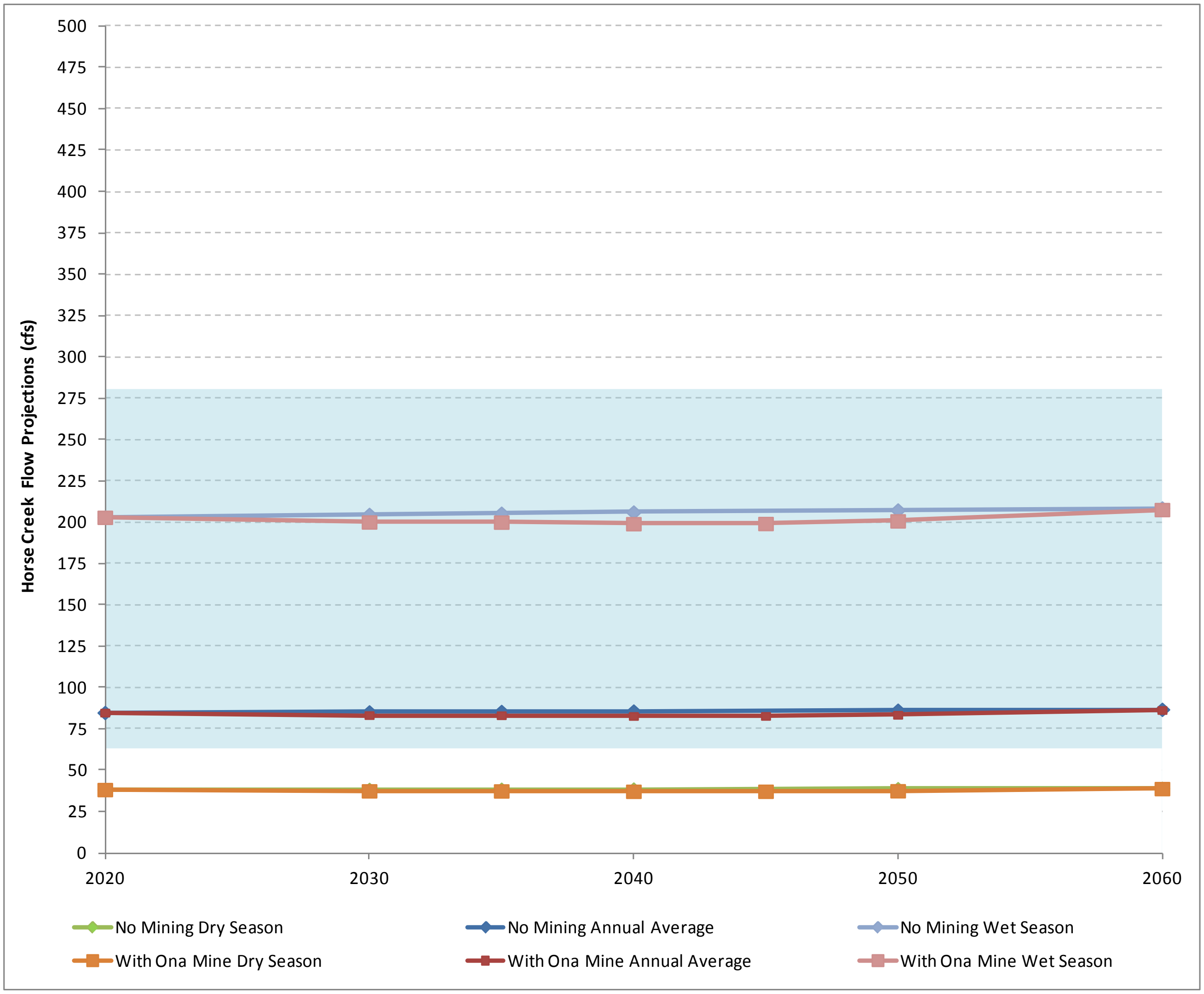


FIGURE 41
Horse Creek Annual Average and Seasonal Projected Flows for Low Annual Rainfall based on 50 Percent Capture of Excess Rainfall with and without Ona Mine



5.3.2 Ona Mine Impacts on Peace River at Arcadia

Table 28 presents the flow and percent change from 2009 average annual and seasonal flows during an average rainfall year with 100 percent capture of stormwater in the capture area of the Ona Mine at the Peace River at Arcadia flow station. The maximum influence was predicted to occur between 2040 based on the capture curve. Like Desoto, the amount of area impacted in this subwatershed is relatively small. Based on land use changes within the subwatershed and upstream subwatersheds, annual flow is predicted to increase during the Ona mining period. Annual average flow increases by approximately 5 to 8 percent during the period of 2040 and 2050, dry season flow increases by approximately 4 to 6 percent, and wet season flow increases by approximately 7 to 10 percent from 2009 levels. Flows are predicted to increase from 2009 levels by approximately 10 percent by 2060. Because of the small percentage of land that would be mined compared to the total drainage area of this gage station, the changes in land use are predicted to have more of an effect on flow than the Ona Mine capture.

TABLE 28

Projected Flows and Percent Change from 2009 Flows during Average Rainfall Year and 100 Percent Capture at the Peace River at Arcadia Flow Station with the Ona Mine

	Annual Average Flow (cfs)	Annual Average Percent Change from 2009 Flows	Dry Season Average Flow (cfs)	Dry Season Average Percent Change from 2009 Flows	Wet Season Average Flow (cfs)	Wet Season Average Percent Change from 2009 Flows
2009	713	0%	328	0%	1,657	0%
2020	726	2%	332	1%	1,701	3%
2030	736	3%	335	2%	1,741	5%
2040	750	5%	340	4%	1,780	7%
2050	769	8%	349	6%	1,825	10%
2060	782	10%	354	8%	1,858	12%

Table 29 presents the flow and percent change from 2009 average annual and seasonal flows during an average rainfall year with 50 percent capture of stormwater in the capture area of the Ona Mine at the Peace River at Arcadia gage station. The maximum influence was predicted to occur between 2040 and 2050 based on the capture analysis. However, similar to the 100 percent capture case, based on land use changes within the subwatershed and upstream subwatersheds, flows are predicted to increase during the Ona mining period. Annual average flow increases by approximately 6 to 8 percent during the period of 2040 and 2050, dry season flow increases by approximately 4 to 7 percent, and wet season flow increases by approximately 8 to 10 percent from 2009 levels. Flows are predicted to increase from 2009 levels by approximately 10 percent by 2060. Again, the small percentage of land that would be mined compared to the total drainage area of this gage station causes the land use to have more of an effect on flow than the Ona Mine capture, and flows are projected to be the about same as in the 100 percent capture case.

TABLE 29

Projected Flows and Percent Change from 2009 Flows during Average Rainfall Year and 50 Percent Capture at the Peace River at Arcadia Flow Station with the Ona Mine

	Annual Average Flow (cfs)	Annual Average Percent Change from 2009 Flows	Dry Season Average Flow (cfs)	Dry Season Average Percent Change from 2009 Flows	Wet Season Average Flow (cfs)	Wet Season Average Percent Change from 2009 Flows
2009	713	0%	328	0%	1,657	0%
2020	726	2%	332	1%	1,702	3%
2030	738	4%	336	2%	1,742	5%
2040	753	6%	342	4%	1,783	8%
2050	771	8%	350	7%	1,827	10%
2060	783	10%	355	8%	1,858	12%

The same evaluation was performed for a low rainfall year. Low rainfall conditions were estimated as the 20th percentile of the annual rainfall totals for the period of record (i.e., 80 percent of the years had higher rainfall). Table 30 presents the flow and percent change from 2009 average annual and seasonal flows during a low rainfall year with 100 percent capture of stormwater in the capture area of the Ona Mine. The maximum influence is predicted to occur between 2040 and 2050 based on the capture analysis. However, identical to the average rainfall scenarios, based on projected land use changes within the subwatershed and upstream subwatersheds, annual flow is predicted to increase during the Ona mining period. Annual average flow increases by approximately 5 to 8 percent during the period of 2040 and 2050, dry season flow increases by approximately

4 to 7 percent, and wet season flow increases by approximately 8 to 11 percent from 2009 levels. Flows are predicted to increase from 2009 levels by approximately 10 percent by 2060. The changes in projected land use are predicted to have more of an effect on flow than the Ona Mine capture.

TABLE 30

Projected Flows and Percent Change from 2009 Flows during Low Rainfall Year and 100 Percent Capture at the Peace River at Arcadia Flow Station with the Ona Mine

	Annual Average Flow (cfs)	Annual Average Percent Change from 2009 Flows	Dry Season Average Flow (cfs)	Dry Season Average Percent Change from 2009 Flows	Wet Season Average Flow (cfs)	Wet Season Average Percent Change from 2009 Flows
2009	330	0%	152	0%	766	0%
2020	336	2%	154	1%	787	3%
2030	341	3%	155	2%	806	5%
2040	348	5%	158	4%	825	8%
2050	357	8%	162	7%	847	11%
2060	363	10%	164	8%	862	13%

Table 31 presents the flow and percent change from 2009 average annual and seasonal flows during a low rainfall year with 50 percent capture of stormwater in the capture area of the Ona Mine. The maximum influence was predicted to occur between 2040 and 2050 based on the capture analysis. However, similar to the average rainfall year scenario, based on land use changes within the subwatershed and upstream subwatersheds, annual flow is predicted to increase during the Ona mining period. Annual average flow increases by approximately 6 to 9 percent during the period of 2040 and 2050, dry season flow increases by approximately 5 to 7 percent, and wet season flow increases by approximately 8 to 11 percent from 2009 levels. Flows are predicted to increase from 2009 levels by approximately 10 percent by 2060. Again, the changes in projected land use are predicted to have more of an effect on flow than the Ona Mine capture, and flows are projected to be the about same as in the 100 percent capture case.

TABLE 31

Projected Flows and Percent Change from 2009 Flows during Low Rainfall Year and 50 Percent Capture at the Peace River at Arcadia Flow Station with the Ona Mine

	Annual Average Flow (cfs)	Annual Average Percent Change from 2009 Flows	Dry Season Average Flow (cfs)	Dry Season Average Percent Change from 2009 Flows	Wet Season Average Flow (cfs)	Wet Season Average Percent Change from 2009 Flows
2009	330	0%	152	0%	766	0%
2020	336	2%	154	1%	787	3%
2030	342	4%	156	3%	807	5%
2040	349	6%	159	5%	826	8%
2050	358	9%	163	7%	848	11%
2060	363	10%	165	9%	862	13%

To illustrate the effect on Peace River at Arcadia stream flow under the conditions and scenarios evaluated, the results are presented graphically and compared to the No Action Alternative conditions. Figures 42 and 43 present the seasonal and annual average flows calculated for the Peace River at Arcadia gage station with and without the Ona Mine based on 100 percent capture and 50 percent capture of stormwater, respectively, during average rainfall conditions.

FIGURE 42

Peace River at Arcadia Annual Average and Seasonal Projected Flows for Average Annual Rainfall based on 100 Percent Capture of Excess Rainfall with and without Ona Mine

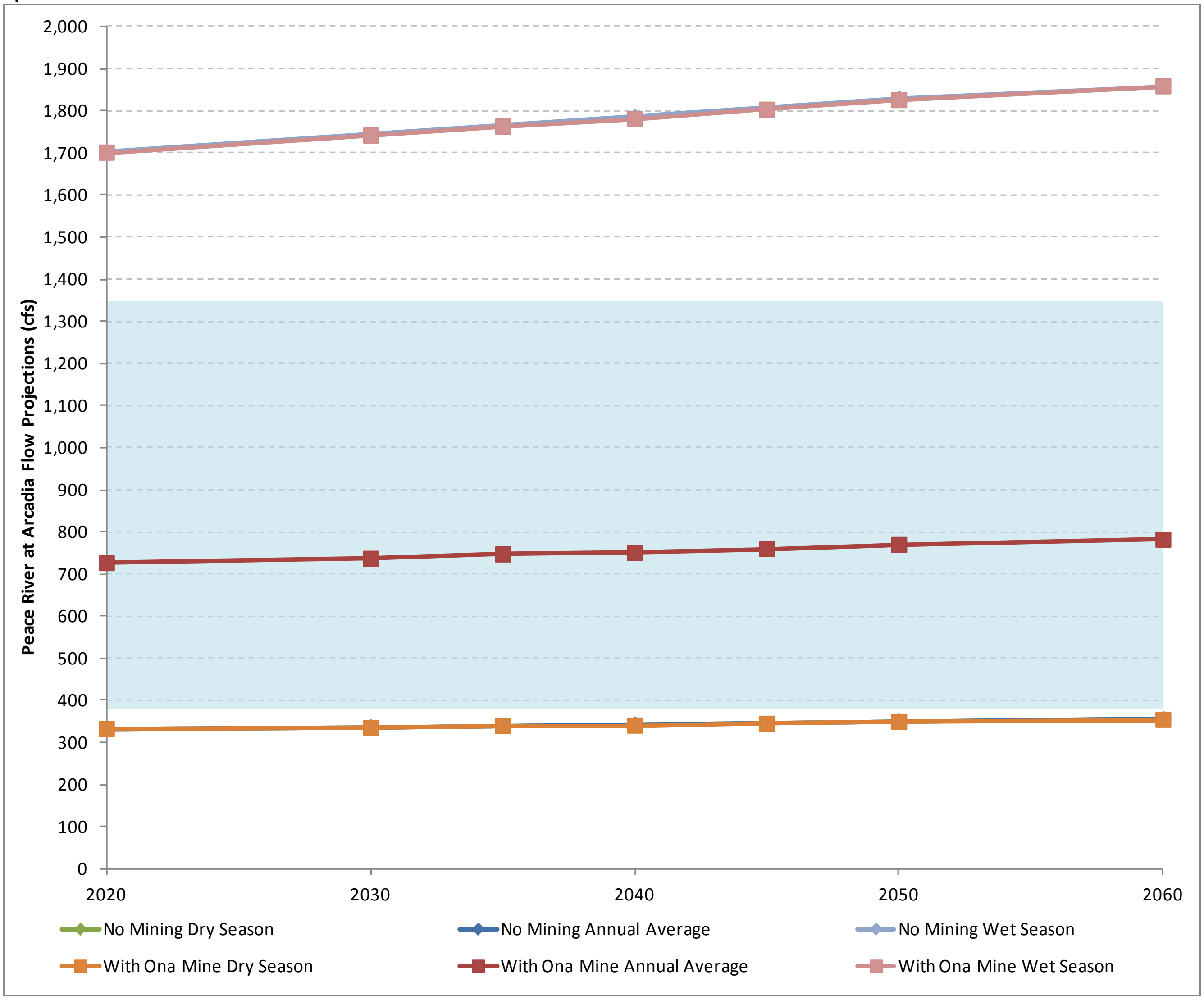
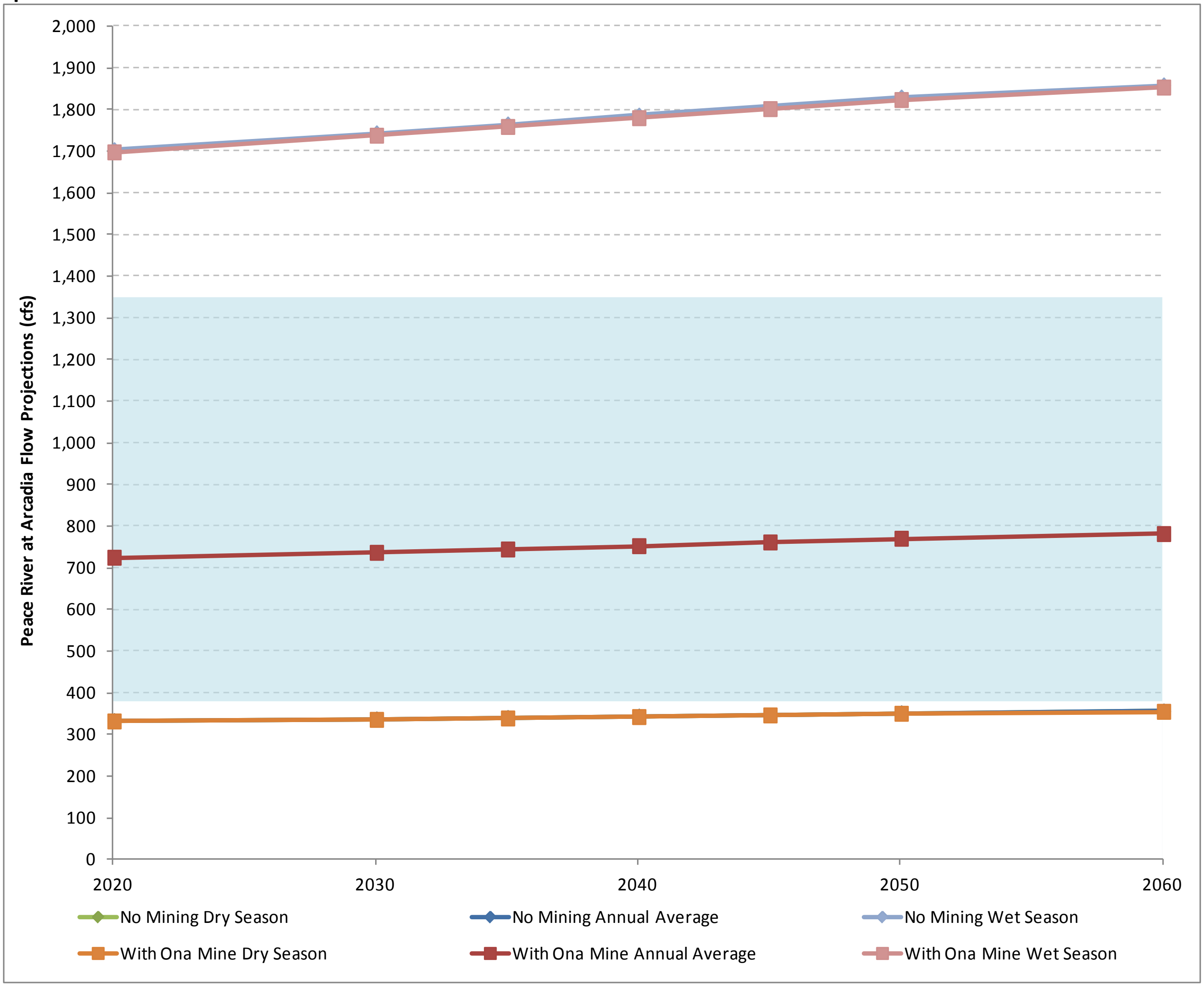


FIGURE 43

Peace River at Arcadia Annual Average and Seasonal Projected Flows for Average Annual Rainfall based on 50 Percent Capture of Excess Rainfall with and without Ona Mine



The largest influence on annual average flow from the Peace River at Arcadia subwatershed during average rainfall conditions is predicted to occur between 2040 and 2050 based on the capture analysis. Based on 100 percent capture of stormwater, Peace River at Arcadia may have an average annual flow of approximately 754 to 772 cfs without the Ona Mine (No Action Alternative) and approximately 750 to 769 cfs with the Ona Mine during that period. Assuming a 50 percent capture of stormwater, Peace River at Arcadia may have an average annual flow of approximately 752 to 770 cfs. This corresponds to a decrease in flow of about 2 cfs when compared to the No Action Alternative conditions (again, overlapping curves).

Figures 44 and 45 present the seasonal and annual average flows calculated for the Peace River at Arcadia gage station with and without the Ona Mine based on 100 percent capture and 50 percent capture of stormwater, respectively, during low rainfall conditions.

FIGURE 44

Peace River at Arcadia Annual Average and Seasonal Projected Flows for Low Annual Rainfall based on 100 Percent Capture of Excess Rainfall with and without Ona Mine

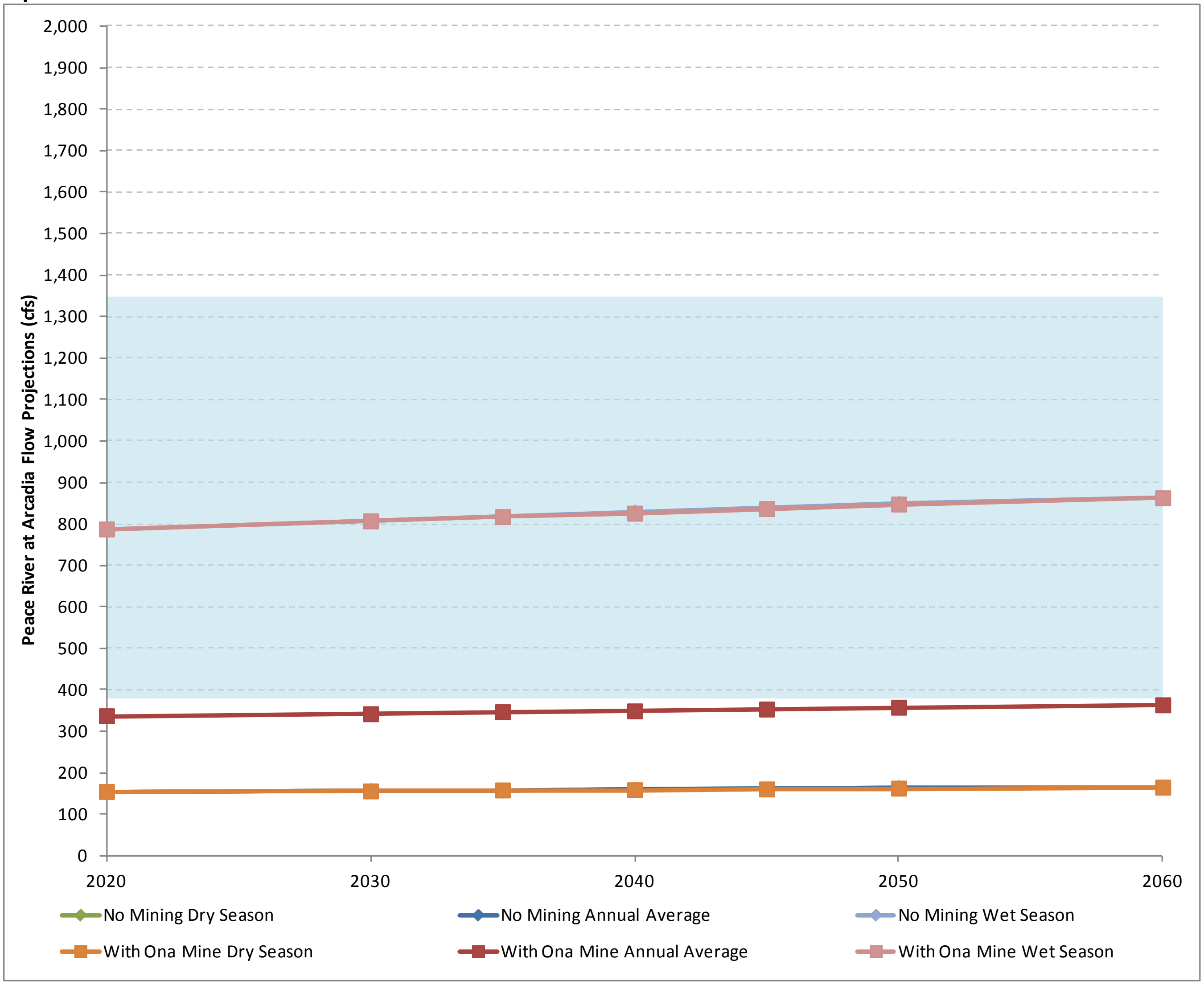
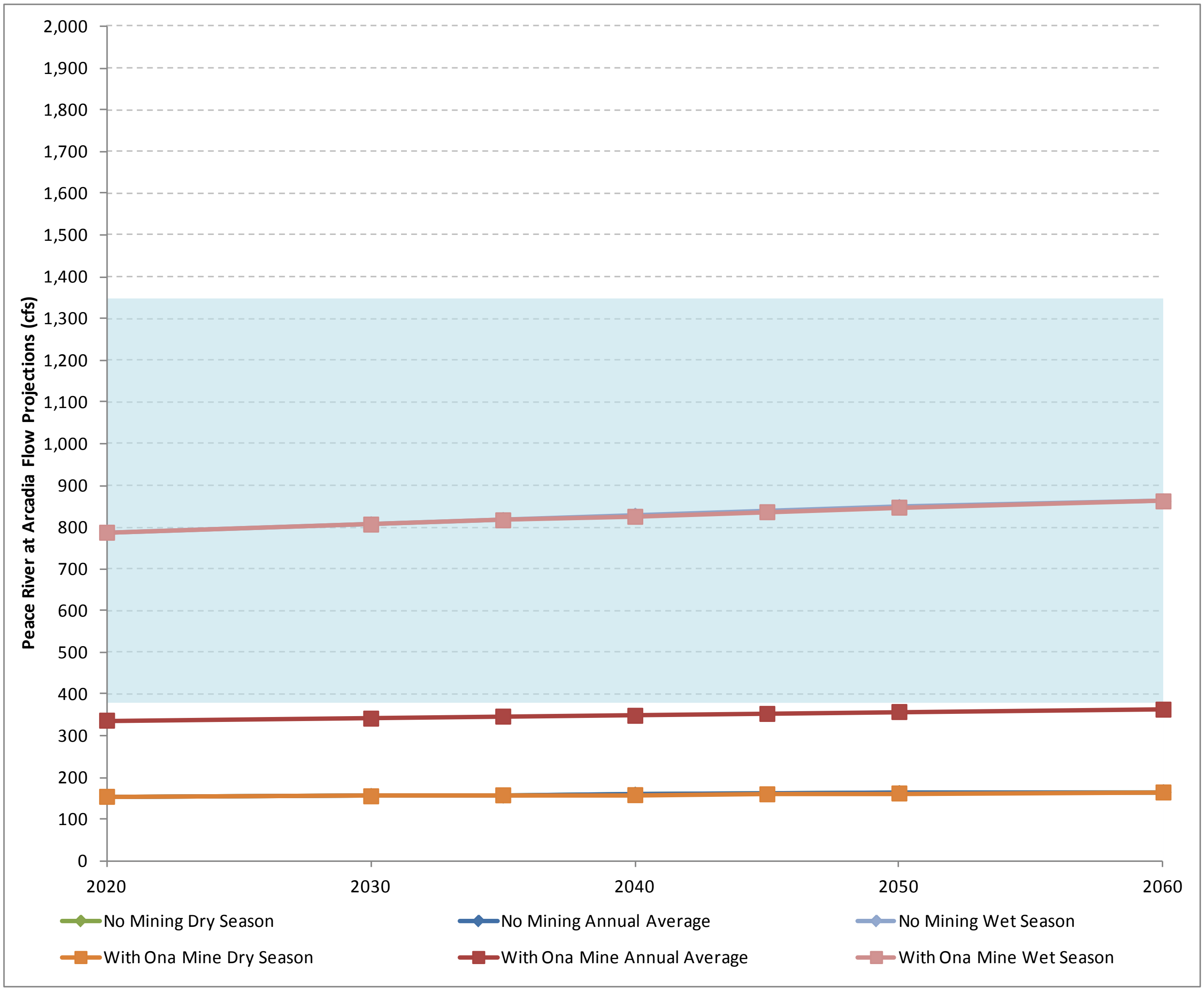


FIGURE 45

Peace River at Arcadia Annual Average and Seasonal Projected Flows for Low Annual Rainfall based on 50 Percent Capture of Excess Rainfall with and without Ona Mine



Similar to average rainfall conditions, the largest influence on annual average flow from the Horse Creek subwatershed during low rainfall conditions was predicted to occur between 2040 and 2050 based on the capture analysis. Based on 100 percent capture of stormwater, Horse Creek may have an average annual flow of approximately 350 to 358 cfs without the Ona Mine (No Action Alternative) and approximately 348 to 357 cfs with the Ona Mine during that period. Assuming a 50 percent capture of stormwater, Horse Creek may have an average annual flow of approximately 349 to 358 cfs, almost identical to the 100 percent capture case. This corresponds to a decrease in flow of 1 to 2 cfs when compared to the No Action Alternative conditions.

The Ona Mine area would comprise a small relative contribution to the flows measured at the Peace River at Arcadia gage station. Ona Mine effect on flow quantities at this station would likely not be perceivable, particularly since flows would be expected to increase because of projected land use changes in the Peace River at Arcadia drainage area.

5.4 Wingate East Mine Impacts on Runoff Characteristics and Stream Flow

The capture curve indicates that the most area under surface water management controls for this alternative is relatively similar between 2030 and 2050 for the Upper Myakka River subwatershed. Table 32 presents the flow and percent change from 2009 average annual and seasonal flows during an average rainfall year with 100 percent capture of stormwater in the capture area of the Wingate East Mine at the upper Myakka River gage station. The maximum influence was predicted to occur between 2030 and 2050 according to the capture analysis. However, based on projected land use changes within the subwatershed and upstream subwatersheds, flows are predicted to increase during the Wingate mining period. Annual average flow increases by approximately 6 to 11 percent during the period of 2030 and 2050, dry season flow increases by approximately 6 to 12 percent, and wet season flow increases by approximately 5 to 11 percent from 2009 levels. Flows are predicted to increase from 2009 levels by approximately 15 percent by 2060. Because the small percentage of land that would be mined compared to the total drainage area of this gage station, and the fact that approximately 60 percent of the Wingate East Mine would be wet dredged and there would be less storage available to capture stormwater, the changes in land use are predicted to have more of an effect on flow than the Wingate East Mine capture.

TABLE 32
Projected Flows and Percent Change from 2009 Flows during Average Rainfall Year and 100 Percent Capture at the Upper Myakka Flow Station with the Wingate East Mine

	Annual Average Flow (cfs)	Annual Average Percent Change from 2009 Flows	Dry Season Average Flow (cfs)	Dry Season Percent Change from 2009 Flows	Wet Season Average Flow (cfs)	Wet Season Percent Change from 2009 Flows
2009	243	0%	109	0%	589	0%
2020	251	3%	113	3%	607	3%
2030	257	6%	115	6%	620	5%
2040	264	8%	118	9%	635	8%
2050	271	11%	122	12%	652	11%
2060	279	15%	125	15%	671	14%

Table 33 presents the flow and percent change from 2009 average annual and seasonal flows during an average rainfall year with 50 percent capture of stormwater in the capture area of the Wingate East Mine at the upper Myakka River gage station. The maximum influence was predicted to occur between 2030 and 2050 based on the capture analysis. However, similar to the 100 percent capture case, based on land use changes within the subwatershed and upstream subwatersheds, flows are predicted to increase during the Wingate East mining period. Annual average flow increases by approximately 6 to 12 percent during the period of 2030 and 2050, dry season flow increases by approximately 6 to 12 percent, and wet season flow increases by approximately 6 to 11 percent from 2009 levels. Flows are predicted to increase from 2009 levels by approximately 15 percent by 2060.

TABLE 33
Projected Flows and Percent Change from 2009 Flows during Average Rainfall Year and 50 Percent Capture at the Upper Myakka River Flow Station with the Wingate East Mine

	Annual Average Flow (cfs)	Annual Average Percent Change from 2009 Flows	Dry Season Average Flow (cfs)	Dry Season Percent Change from 2009 Flows	Wet Season Average Flow (cfs)	Wet Season Percent Change from 2009 Flows
2009	243	0%	109	0%	589	0%
2020	251	3%	113	3%	607	3%
2030	258	6%	116	6%	622	6%
2040	265	9%	119	9%	638	8%
2050	271	12%	122	12%	654	11%
2060	279	15%	125	15%	671	14%

The same evaluation was performed for a low rainfall year. For the Wingate East Mine analysis, this low rainfall calculation used 43 inches of rainfall per year, the same low rainfall volume as in the Peace River watershed. Table 34 presents the flow and percent change from 2009 average annual and seasonal flows during a low rainfall year with 100 percent capture of stormwater in the capture area of the Wingate East Mine. The maximum influence is predicted to occur between 2030 and 2050 based on the capture analysis. However, identical to the average rainfall scenarios, based on land use changes within the subwatershed and upstream subwatersheds, flows are predicted to increase during the Wingate mining period. Annual average flow increases by approximately 6 to 11 percent during the period of 2030 and 2050, dry season flow increases by approximately 6 to 12 percent, and wet season flow increases by approximately 5 to 11 percent from 2009 levels. Flows are predicted to increase from 2009 levels by approximately 15 percent by 2060.

TABLE 34

Projected Flows and Percent Change from 2009 Flows during Low Rainfall Year and 100 Percent Capture at the Upper Myakka River Flow Station with the Wingate East Mine

	Annual Average Flow (cfs)	Annual Average Percent Change from 2009 Flows	Dry Season Average Flow (cfs)	Dry Season Percent Change from 2009 Flows	Wet Season Average Flow (cfs)	Wet Season Percent Change from 2009 Flows
2009	197	0%	88	0%	478	0%
2020	204	3%	91	3%	492	3%
2030	208	6%	93	6%	503	5%
2040	214	8%	96	9%	516	8%
2050	220	11%	99	12%	529	11%
2060	226	15%	102	15%	544	14%

Table 35 presents the flow and percent change from 2009 average annual and seasonal flows during a low rainfall year with 50 percent capture of stormwater in the capture area of the Wingate East Mine. The maximum influence was predicted to occur between 2030 and 2050 based on the capture analysis. However, similar to the average rainfall year scenario, based on land use changes within the subwatershed and upstream subwatersheds, flows are predicted to increase during the Wingate mining period. Annual average flow increases by approximately 6 to 12 percent during the period of 2030 and 2050, dry season flow increases by approximately 6 to 12 percent, and wet season flow increases by approximately 6 to 11 percent from 2009 levels. Flows are predicted to increase from 2009 levels by approximately 15 percent by 2060. Considering the small percentage of land that would be mined compared to the total drainage area of this gage station, and the fact that approximately half of the Wingate East Mine is planned to be dredged, the changes in land use are predicted to have more of an effect on flow than the Wingate East Mine capture, and flows are projected to be about the same as in the 100 percent capture case.

TABLE 35

Projected Flows and Percent Change from 2009 Flows during Low Rainfall Year and 50 Percent Capture at the Upper Myakka River Flow Station with the Wingate East Mine

	Annual Average Flow (cfs)	Annual Average Percent Change from 2009 Flows	Dry Season Average Flow (cfs)	Dry Season Percent Change from 2009 Flows	Wet Season Average Flow (cfs)	Wet Season Percent Change from 2009 Flows
2009	197	0%	88	0%	478	0%
2020	204	3%	91	3%	492	3%
2030	209	6%	94	6%	505	6%
2040	215	9%	96	9%	517	8%
2050	220	12%	99	12%	530	11%
2060	226	15%	102	15%	544	14%

To illustrate the effect on upper Myakka River stream flow under the conditions and scenarios evaluated, the results are presented graphically and compared to the No Action Alternative conditions. Figures 46 and 47 present the seasonal and annual average flows calculated for the upper Myakka River gage station with and without the Wingate East Mine based on 100 percent capture and 50 percent capture of stormwater, respectively, during average rainfall conditions.

FIGURE 46
Upper Myakka River Annual Average and Seasonal Projected Flows for Average Annual Rainfall based on 100 Percent Capture of Excess Rainfall with and without Wingate East Mine

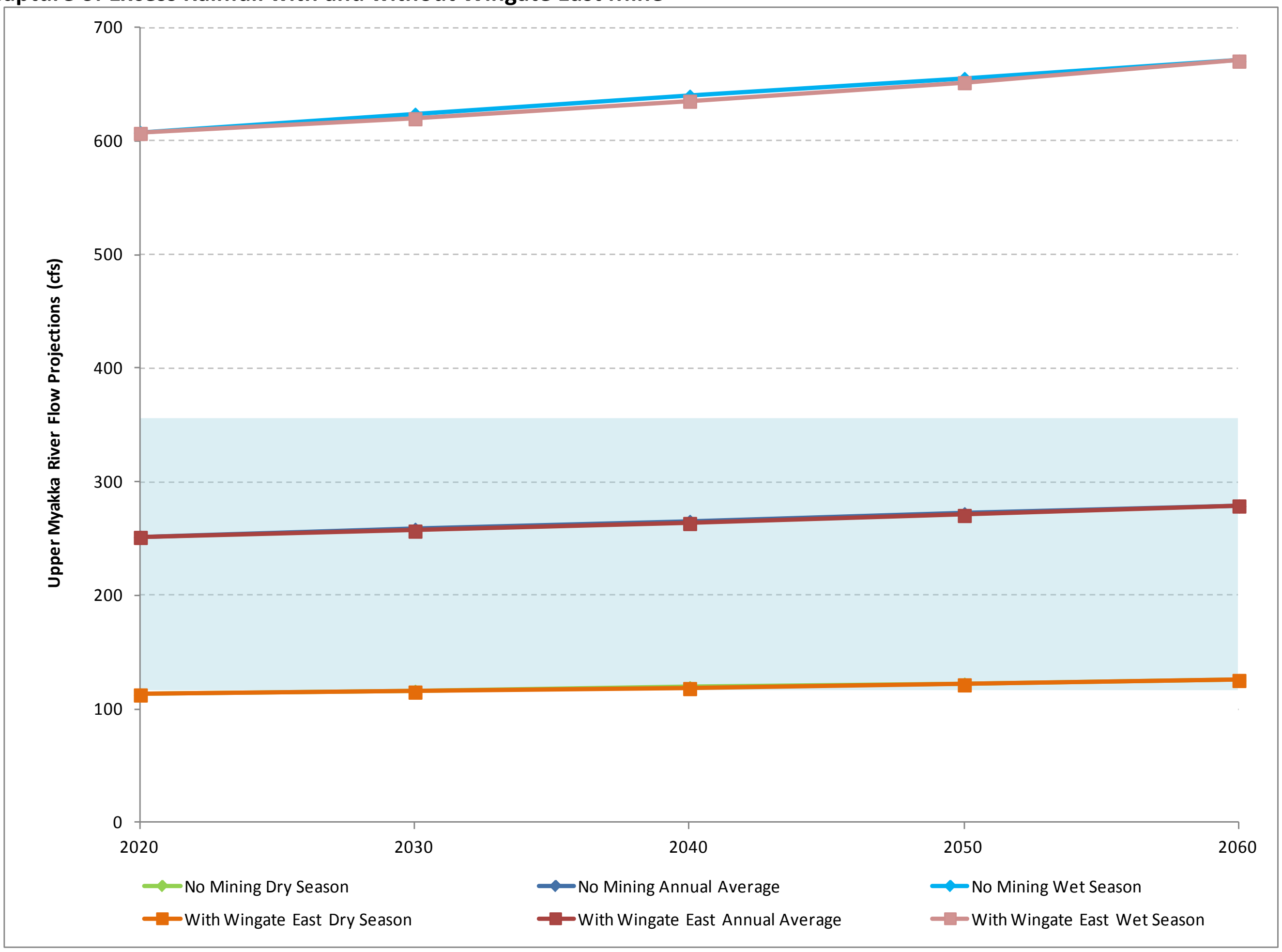
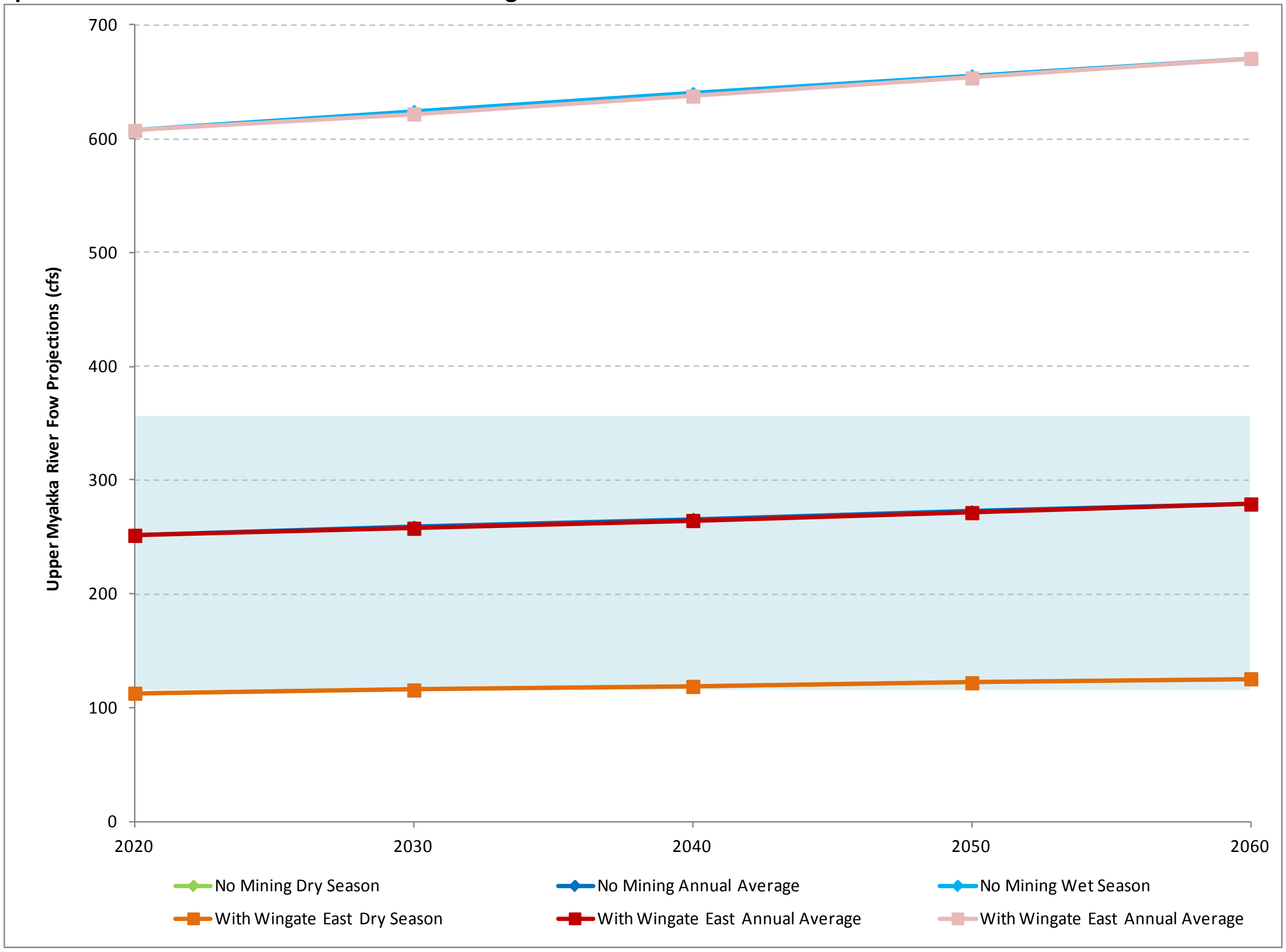


FIGURE 47
Upper Myakka River Annual Average and Seasonal Projected Flows for Average Annual Rainfall based on 50 Percent Capture of Excess Rainfall with and without Wingate East Mine



The largest influence on annual average flow from the upper Myakka River subwatershed during average rainfall conditions is predicted to occur between 2030 and 2050 based on the capture analysis. Based on 100 percent capture of stormwater, the upper Myakka River may have an average annual flow of approximately 259 to 272 cfs without the Wingate East Mine and approximately 257 to 271 cfs with the Wingate East Mine during that period. Assuming a 50 percent capture of stormwater, Peace River at Arcadia may have an average annual flow of approximately 258 to 271 cfs, almost identical to the 100 percent capture case. This corresponds to a decrease in flow of 1 to 2 cfs when compared to the No Action Alternative conditions.

Figures 48 and 49 present the seasonal and annual average flows calculated for the upper Myakka River gage station with and without the Wingate East Mine based on 100 percent capture and 50 percent capture of stormwater, respectively, during low rainfall conditions. One standard deviation above and below the historical mean flow is presented to illustrate the historical range in stream flow.

FIGURE 48

Upper Myakka River Annual Average and Seasonal Projected Flows for Low Annual Rainfall based on 100 Percent Capture of Excess Rainfall with and without Wingate East Mine

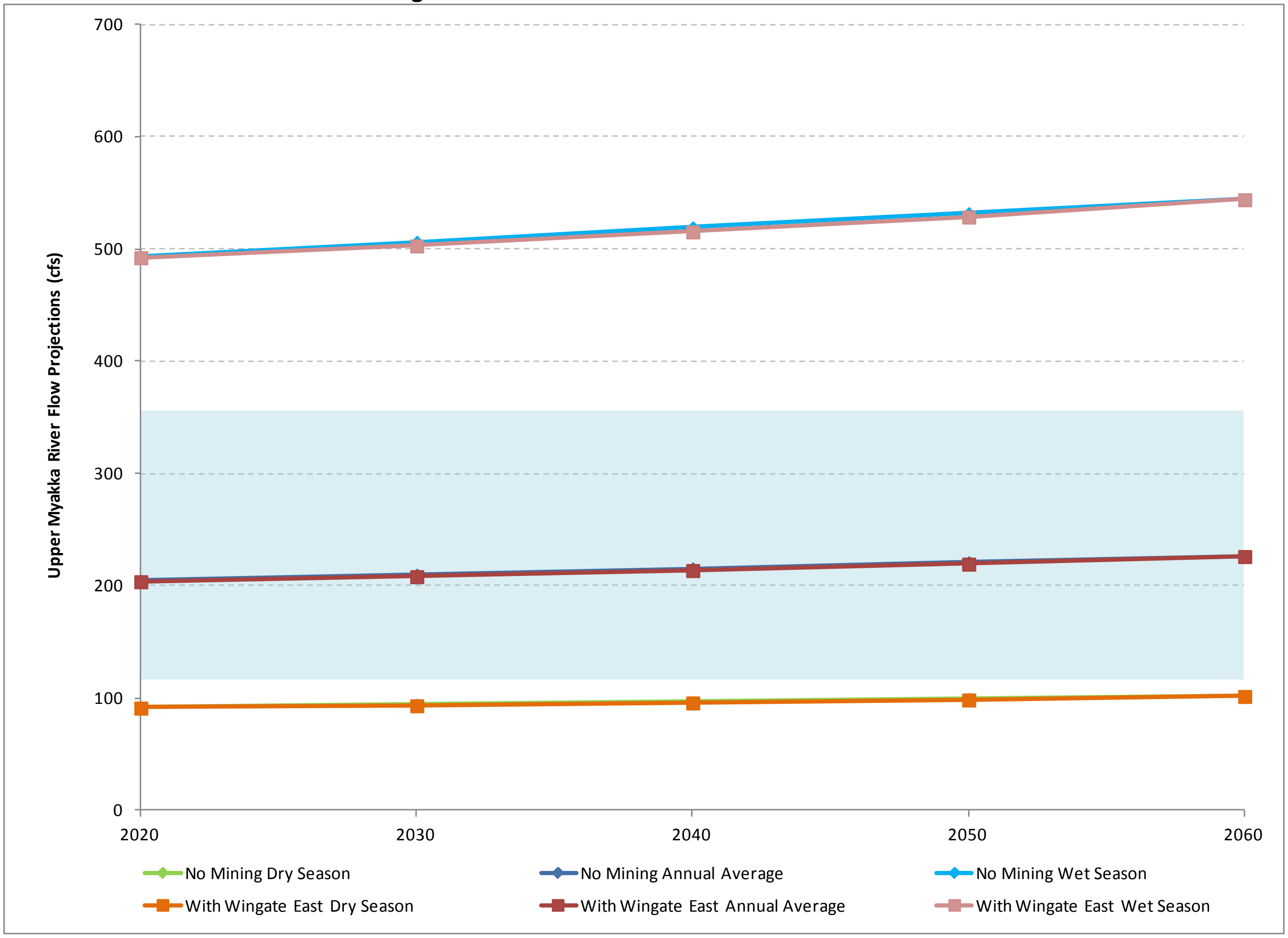
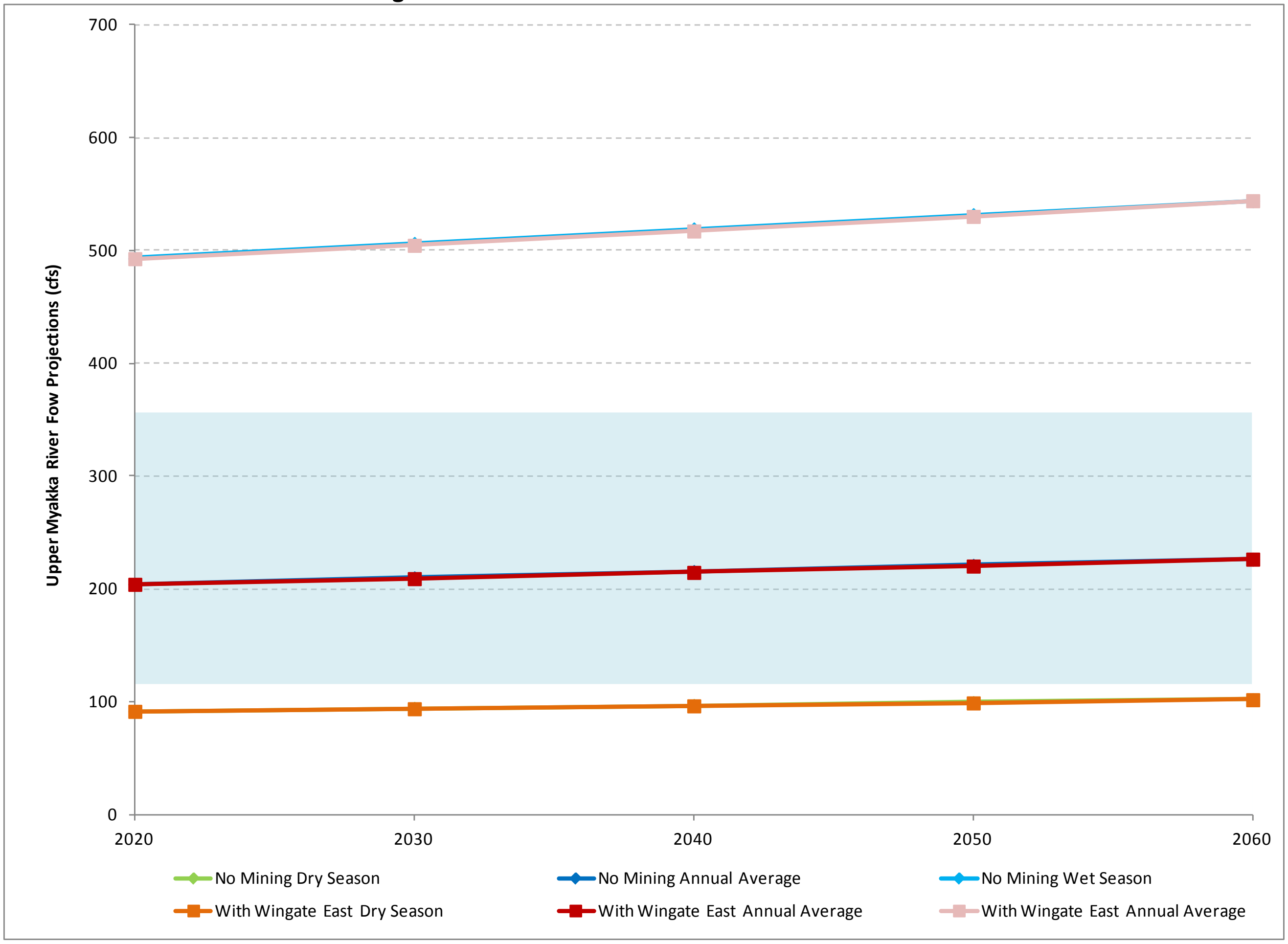


FIGURE 49

Upper Myakka River Annual Average and Seasonal Projected Flows for Low Annual Rainfall based on 50 Percent Capture of Excess Rainfall with and without Wingate East Mine



Similar to average rainfall conditions, the largest influence on annual average flow from the upper Myakka River subwatershed during low rainfall conditions was predicted to occur between 2030 and 2050 based on the capture analysis. Based on 100 percent capture of stormwater the upper Myakka River may have an average annual flow of approximately 210 to 221 cfs without the Wingate East Mine, and approximately 208 to 220 cfs with the Wingate East Mine during that period. Assuming a 50 percent capture of stormwater, the upper Myakka River may have an average annual flow of approximately 209 to 220 cfs, almost identical to the 100 percent capture case. This corresponds to a decrease in flow of about 1 cfs when compared to the No Action Alternative conditions.

The Wingate East Mine would account for a small relative contribution to the flows measured at the upper Myakka River gage station. Wingate East Mine effect on flow quantities at this station would likely not be perceivable, particularly since flows would be expected to increase because of projected land use changes in the upper Myakka River drainage area.

5.5 South Pasture Mine Extension Impacts on Runoff Characteristics and Stream Flow

Similar to the other Applicants' Preferred Alternative in the Horse Creek and Peace River at Arcadia subwatersheds, the effects of the South Pasture Mine Extension were calculated by evaluating the change to the runoff coefficients. The capture curve indicates that the most area under surface water management controls at this alternative is higher around 2030 for the both the Horse Creek and Peace River at Arcadia subwatersheds.

5.5.1 South Pasture Mine Extension Impacts on Horse Creek

Table 36 presents the flow and percent change from 2009 average annual and seasonal flows during an average rainfall year with 100 percent capture of stormwater in the capture area of the South Pasture Mine Extension at the Horse Creek flow station (near Arcadia). The maximum influence was predicted to occur around 2030, when annual average flow decreases by approximately 2 percent, dry season flow decreases by approximately 3 percent, and wet season flow decreases by approximately 1 percent from 2009 levels. However, because of changes in projected land use within this watershed, flows are predicted to increase from 2009 levels by 2060.

TABLE 36

Projected Flows and Percent Change from 2009 Flows during Average Rainfall Year and 100 Percent Capture at the Horse Creek Flow Station with the South Pasture Mine Extension

	Annual Average Flow (cfs)	Annual Average Percent Change from 2009 Flows	Dry Season Average Flow (cfs)	Dry Season Average Percent Change from 2009 Flows	Wet Season Average Flow (cfs)	Wet Season Average Percent Change from 2009 Flows
2009	171	0%	78	0%	404	0%
2020	172	0%	77	0%	411	2%
2030	167	-2%	75	-3%	401	-1%
2040	174	2%	78	1%	418	3%
2050	175	3%	79	2%	422	4%
2060	177	3%	79	2%	424	5%

Table 37 presents the flow and percent change from 2009 average annual and seasonal flows during an average rainfall year with 50 percent capture of stormwater in the capture area of the South Pasture Mine Extension at the Horse Creek flow station. The maximum influence was predicted to occur around 2030, when annual average flow is about the same as 2009 levels, dry season flow decreases by approximately 1 percent, and wet season flow increases by approximately 1 percent. However, when considering only the South Pasture Mine Extension annual average flows are predicted to increase by approximately 3 percent when compared to 2009 flows, with dry season flows increasing by 2 percent, and a 5 percent increase in wet weather flows by 2060.

TABLE 37

Projected Flows and Percent Change from 2009 Flows during Average Rainfall Year and 50 Percent Capture at the Horse Creek Flow Station with the South Pasture Mine Extension

	Annual Average Flow (cfs)	Annual Average Percent Change from 2009 Flows	Dry Season Average Flow (cfs)	Dry Season Average Percent Change from 2009 Flows	Wet Season Average Flow (cfs)	Wet Season Average Percent Change from 2009 Flows
2009	171	0%	78	0%	404	0%
2020	172	1%	78	0%	412	2%
2030	170	0%	76	-1%	409	1%
2040	174	2%	78	1%	418	3%
2050	175	3%	79	2%	422	4%
2060	177	3%	79	2%	424	5%

The same evaluation was performed for a low rainfall year. Table 38 presents the flow and percent change from 2009 average annual and seasonal flows during a low rainfall year with 100 percent capture of stormwater in the capture area of the South Pasture Mine Extension at the Horse Creek flow station. The maximum influence was predicted to occur around 2030 based on the capture analysis, when annual average flow decreases by approximately 2 percent, dry season flow decreases by approximately 3 percent, and wet season flow decreases by approximately 1 percent from 2009 levels. However, annual average flows are predicted to increase by 3 percent from 2009 levels by 2060.

TABLE 38

Projected Flows and Percent Change from 2009 Flows during Low Rainfall Year and 100 Percent Capture at the Horse Creek Flow Station with the South Pasture Mine Extension

	Annual Average Flow (cfs)	Annual Average Percent Change from 2009 Flows	Dry Season Average Flow (cfs)	Dry Season Average Percent Change from 2009 Flows	Wet Season Average Flow (cfs)	Wet Season Average Percent Change from 2009 Flows
2009	84	0%	38	0%	199	0%
2020	84	0%	38	0%	202	2%
2030	82	-2%	37	-3%	197	-1%
2040	85	2%	38	1%	205	3%
2050	86	3%	39	2%	207	4%
2060	87	3%	39	2%	209	5%

Table 39 presents the flow and percent change from 2009 average annual and seasonal flows during a low rainfall year with 50 percent capture of stormwater in the capture area of the South Pasture Mine Extension at the Horse Creek flow station. The maximum influence was predicted to occur around 2030, when annual average flow remains about the same as 2009 levels, dry season flow decreases by approximately 1 percent, and wet season flow increases by 1 percent from 2009 levels. However, when considering only the South Pasture Mine Extension, annual average flow is predicted to increase by approximately 3 percent when compared to 2009 flows with an 2 percent increase in dry season flow and a 5 percent increase in wet season flow under low rainfall conditions by 2060.

TABLE 39

Projected Flows and Percent Change from 2009 Flows during Low Rainfall Year and 50 Percent Capture at the Horse Creek Flow Station with the South Pasture Mine Extension

	Annual Average Flow (cfs)	Annual Average Percent Change from 2009 Flows	Dry Season Average Flow (cfs)	Dry Season Average Percent Change from 2009 Flows	Wet Season Average Flow (cfs)	Wet Season Average Percent Change from 2009 Flows
2009	84	0%	38	0%	199	0%
2020	85	1%	38	0%	202	2%
2030	84	0%	38	-1%	201	1%
2040	86	2%	38	1%	206	3%
2050	86	3%	39	2%	207	4%
2060	87	3%	39	2%	209	5%

To illustrate the effect on Horse Creek stream flow under the conditions and scenarios evaluated, the results are presented graphically and compared to the No Action Alternative conditions. Figures 50 and 51 present the seasonal and annual average flows calculated for the Horse Creek gage station with and without the South Pasture Mine Extension based on 100 percent capture and 50 percent capture of stormwater, respectively, during average rainfall conditions.

FIGURE 50

Horse Creek Annual Average and Seasonal Projected Flows for Average Annual Rainfall based on 100 Percent Capture of Excess Rainfall with and without South Pasture Mine Extension

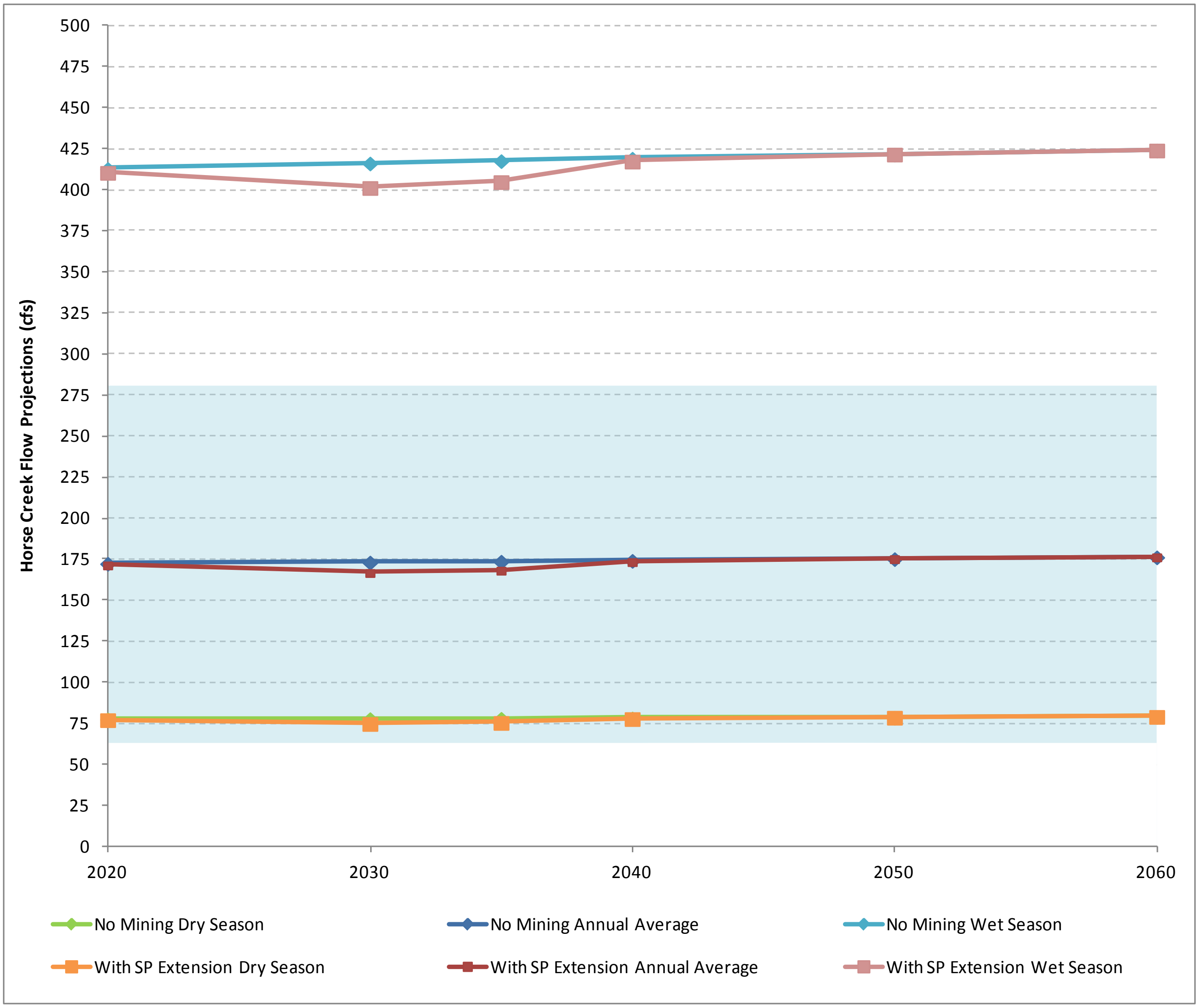
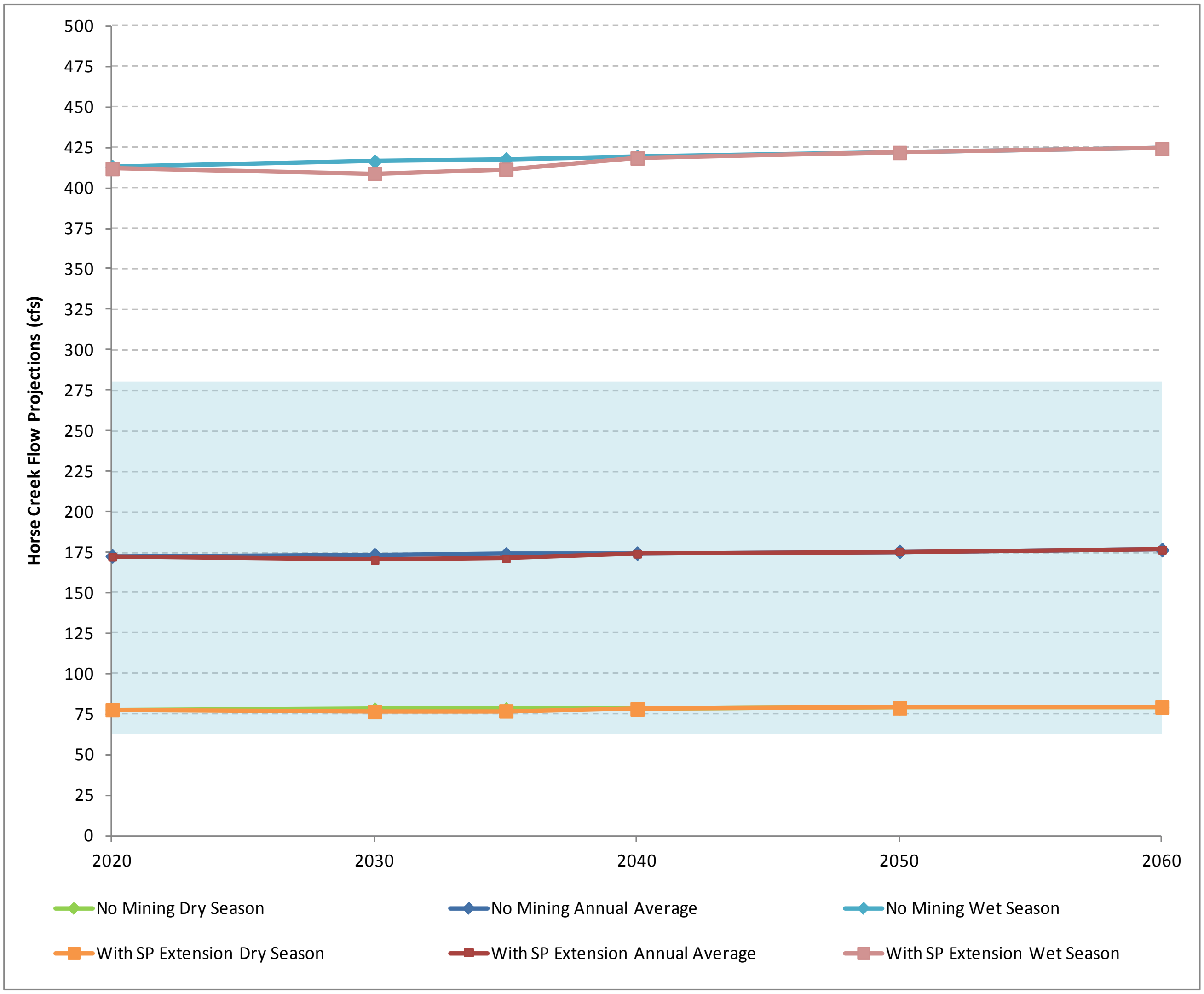


FIGURE 51

Horse Creek Annual Average and Seasonal Projected Flows for Average Annual Rainfall based on 50 Percent Capture of Excess Rainfall with and without South Pasture Mine Extension



The largest influence on annual average flow from the Horse Creek subwatershed during average rainfall conditions was predicted to occur around 2030 based on the capture analysis. Based on 100 percent capture of stormwater, Horse Creek may have an average annual flow of approximately 173 cfs without the South Pasture Mine Extension and approximately 167 cfs with the South Pasture Mine Extension. Assuming a 50 percent capture of stormwater, Horse Creek may have an average annual flow of approximately 170 cfs. This corresponds to a decrease in flow of 3 cfs when compared to the No Action Alternative conditions.

Figures 52 and 53 present the seasonal and annual average flows calculated for the Horse Creek gage station with and without the South Pasture Mine Extension based on 100 percent capture and 50 percent capture of stormwater, respectively, during low rainfall conditions.

FIGURE 52

Horse Creek Annual Average and Seasonal Projected Flows for Low Annual Rainfall based on 100 Percent Capture of Excess Rainfall with and without the South Pasture Mine Extension

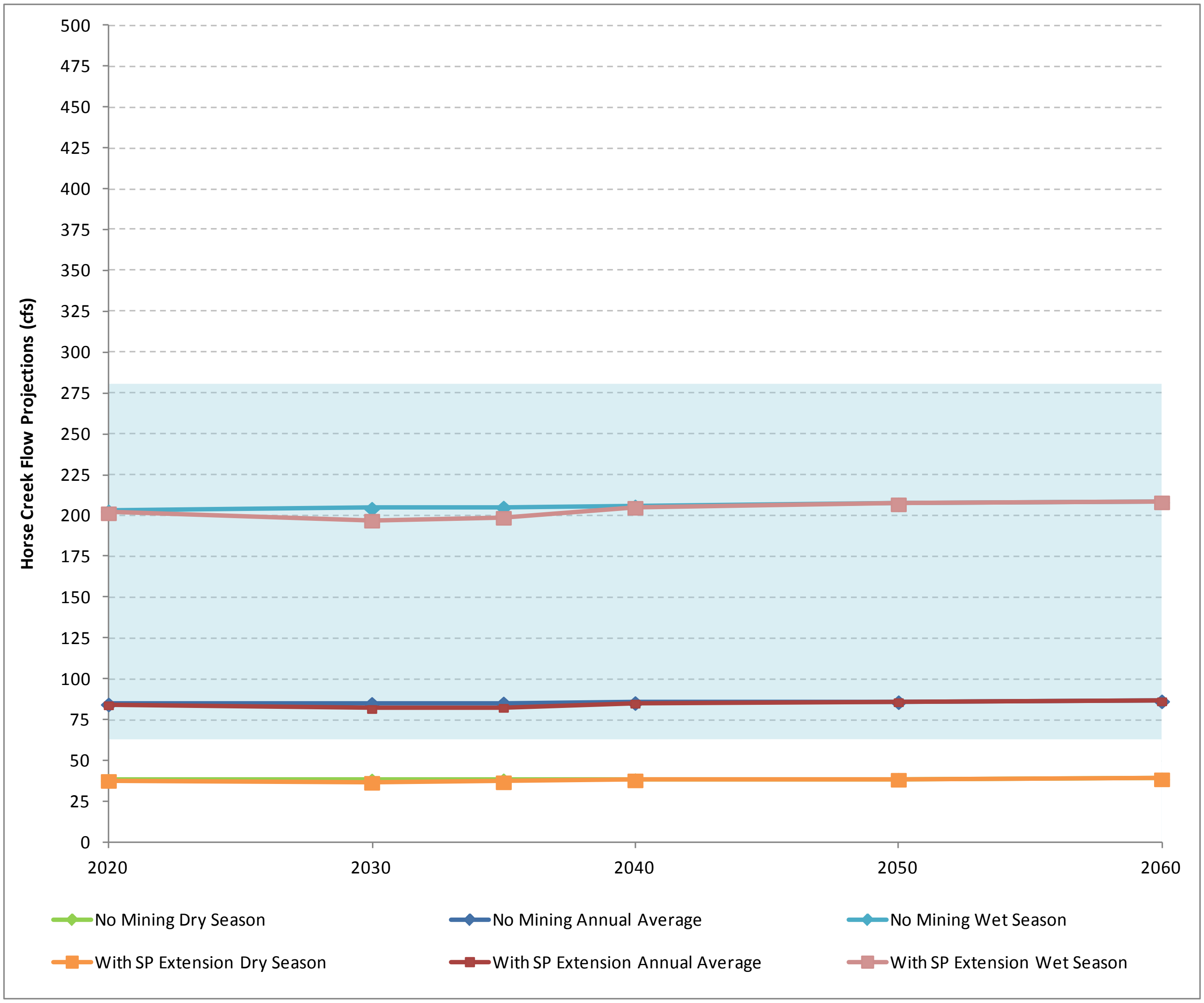
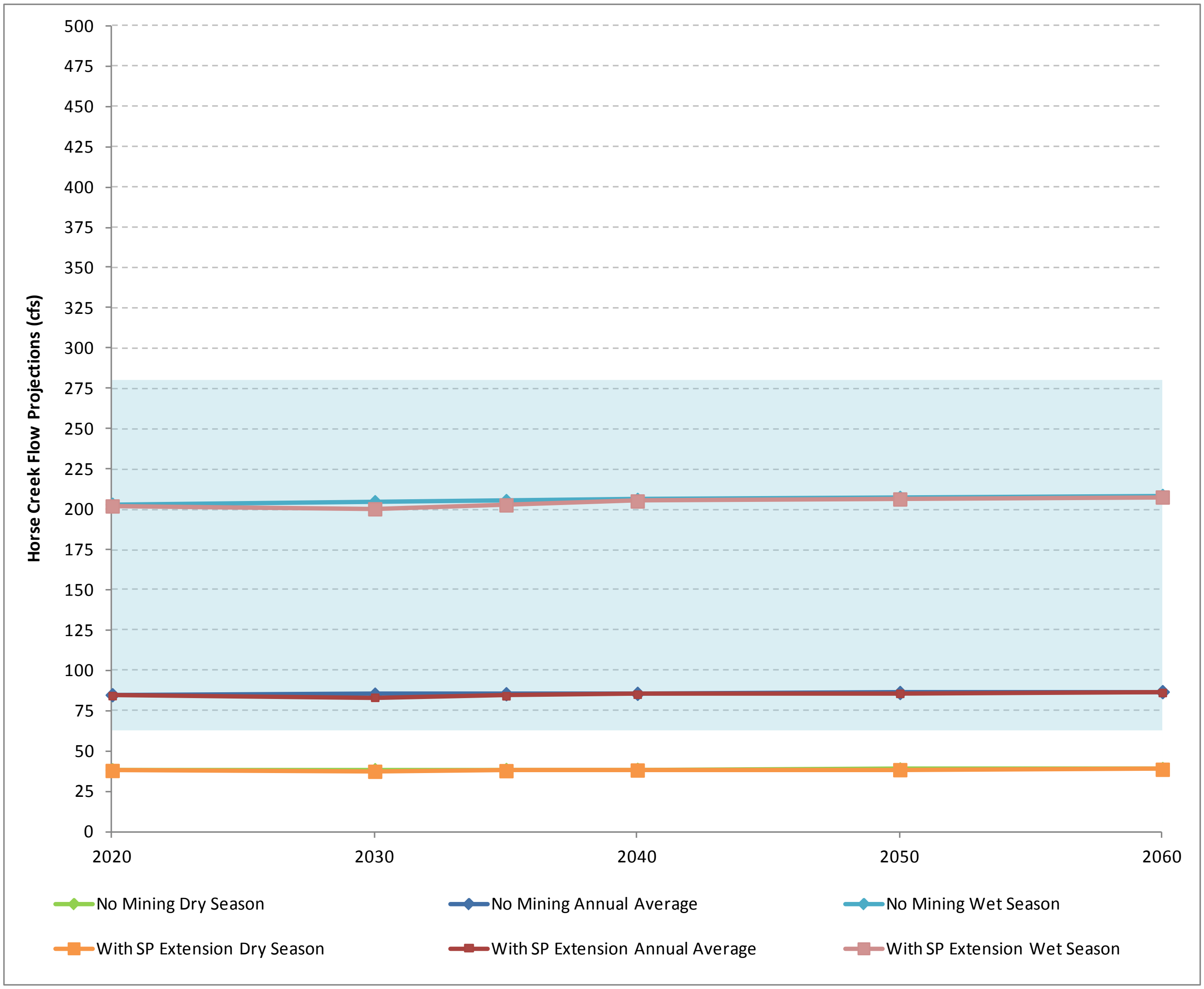


FIGURE 53
Horse Creek Annual Average and Seasonal Projected Flows for Low Annual Rainfall based on 50 Percent Capture of Excess Rainfall with and without South Pasture Mine Extension



Similar to average rainfall conditions, the largest influence on annual average flow from the Horse Creek subwatershed during low rainfall conditions was predicted to occur around 2030. Based on 100 percent capture of stormwater, Horse Creek may have an average annual flow of approximately 85 cfs without the South Pasture Mine Extension and approximately 82 cfs with the South Pasture Mine Extension. Assuming a 50 percent capture of stormwater, Horse Creek may have an average annual flow of approximately 84 cfs. This corresponds to a decrease in flow of 1 cfs when compared to the No Action Alternative conditions.

5.5.2 South Pasture Mine Extension Impacts on Peace River at Arcadia

Table 40 presents the flow and percent change from 2009 average annual and seasonal flows during an average rainfall year with 100 percent capture of stormwater in the capture area of the South Pasture Mine Extension at the Peace River at Arcadia flow station. The maximum influence was predicted to occur around 2030 based on the capture analysis. However, based on land use changes within the subwatershed and upstream subwatersheds, flows are predicted to increase during the South Pasture Mine Extension mining period. Annual average flow increases by approximately 3 percent by 2030, dry season flow increases by approximately 3 percent, and wet season flow increases by approximately 5 percent from 2009 levels. Flows are predicted to increase from 2009 levels by approximately 10 percent by 2060. Because of the small percentage of land that is being mined compared to the total drainage area of this gage station, the changes in projected land use are predicted to have more of an effect on flow than the South Pasture Mine Extension capture.

TABLE 40

Projected Flows and Percent Change from 2009 Flows during Average Rainfall Year and 100 Percent Capture at the Peace River at Arcadia Flow Station with the South Pasture Mine Extension

	Annual Average Flow (cfs)	Annual Average Percent Change from 2009 Flows	Dry Season Average Flow (cfs)	Dry Season Average Percent Change from 2009 Flows	Wet Season Average Flow (cfs)	Wet Season Average Percent Change from 2009 Flows
2009	713	0%	328	0%	1,657	0%
2020	726	2%	332	1%	1,702	3%
2030	738	3%	336	3%	1,740	5%
2040	754	6%	343	5%	1,785	8%
2050	772	8%	351	7%	1,829	10%
2060	783	10%	355	8%	1,858	12%

Table 41 presents the flow and percent change from 2009 average annual and seasonal flows during an average rainfall year with 50 percent capture of stormwater in the capture area of the South Pasture Mine Extension at the Peace River at Arcadia gage station. The maximum influence was predicted to occur around 2030 based on the capture analysis. However, similar to the 100 percent capture case, based on projected land use changes within the subwatershed and upstream subwatersheds, flows are predicted to increase during the South Pasture Mine Extension mining period. Annual average flow increases by approximately 3 percent by 2030, dry season flow increases by approximately 2 percent, and wet season flow increases by approximately 5 percent from 2009 levels. Flows are predicted to increase from 2009 levels by approximately 10 percent by 2060. For the 50 percent capture case, flows are projected to be about the same as in the 100 percent capture case.

TABLE 41

Projected Flows and Percent Change from 2009 Flows during Average Rainfall Year and 50 Percent Capture at the Peace River at Arcadia Flow Station with the South Pasture Mine Extension

	Annual Average Flow (cfs)	Annual Average Percent Change from 2009 Flows	Dry Season Average Flow (cfs)	Dry Season Average Percent Change from 2009 Flows	Wet Season Average Flow (cfs)	Wet Season Average Percent Change from 2009 Flows
2009	713	0%	328	0%	1,657	0%
2020	726	2%	332	1%	1,702	3%
2030	738	3%	336	2%	1,741	5%
2040	754	6%	343	5%	1,785	8%
2050	772	8%	351	7%	1,829	10%
2060	783	10%	355	8%	1,858	12%

The same evaluation was performed for a low rainfall year. Table 42 presents the flow and percent change from 2009 average annual and seasonal flows during a low rainfall year with 100 percent capture of stormwater in the capture area of the South Pasture Mine Extension. The maximum influence is predicted to occur around 2030 based on the capture analysis. However, identical to the average rainfall scenarios, based on land use changes within the subwatershed and upstream subwatersheds, flows are predicted to increase during the South Pasture Mine Extension mining period. Annual average flow increases by approximately 4 percent by 2030, dry season flow increases by approximately 3 percent, and wet season flow increases by approximately 5 percent from 2009 levels. Flows are predicted to increase from 2009 levels by approximately 10 percent by 2060.

TABLE 42

Projected Flows and Percent Change from 2009 Flows during Low Rainfall Year and 100 Percent Capture at the Peace River at Arcadia Flow Station with the South Pasture Mine Extension

	Annual Average Flow (cfs)	Annual Average Percent Change from 2009 Flows	Dry Season Average Flow (cfs)	Dry Season Average Percent Change from 2009 Flows	Wet Season Average Flow (cfs)	Wet Season Average Percent Change from 2009 Flows
2009	330	0%	152	0%	766	0%
2020	337	2%	154	1%	787	3%
2030	342	4%	156	3%	806	5%
2040	350	6%	159	5%	827	8%
2050	358	9%	163	7%	848	11%
2060	363	10%	165	9%	862	13%

Table 43 presents the flow and percent change from 2009 average annual and seasonal flows during a low rainfall year with 50 percent capture of stormwater in the capture area of the South Pasture Mine Extension. The maximum influence was predicted to occur around 2030 based on the capture analysis. However, similar to the average rainfall year scenario, based on land use changes within the subwatershed and upstream subwatersheds, flows are predicted to increase during the South Pasture Mine Extension mining period. Annual average flow increases by approximately 4 percent by 2030, dry season flow increases by approximately 3 percent, and wet season flow increases by approximately 5 percent from 2009 levels. Flows are predicted to increase from 2009 levels by approximately 10 percent by 2060. Again, flows are projected to be about the same as in the 100 percent capture case.

TABLE 43

Projected Flows and Percent Change from 2009 Flows during Low Rainfall Year and 50 Percent Capture at the Peace River at Arcadia Flow Station with the South Pasture Mine Extension

	Annual Average Flow (cfs)	Annual Average Percent Change from 2009 Flows	Dry Season Average Flow (cfs)	Dry Season Average Percent Change from 2009 Flows	Wet Season Average Flow (cfs)	Wet Season Average Percent Change from 2009 Flows
2009	330	0%	152	0%	766	0%
2020	337	2%	154	1%	787	3%
2030	342	4%	156	3%	806	5%
2040	350	6%	159	5%	827	8%
2050	358	9%	163	7%	848	11%
2060	363	10%	165	9%	862	13%

To illustrate the effect on Peace River at Arcadia stream flow under the conditions and scenarios evaluated, the results are presented graphically and compared to the No Action Alternative conditions. Figures 54 and 55 present the seasonal and annual average flows calculated for the Peace River at Arcadia gage station with and without the South Pasture Mine Extension based on 100 percent capture and 50 percent capture of stormwater respectively during average rainfall conditions.

FIGURE 54

Peace River at Arcadia Annual Average and Seasonal Projected Flows for Average Annual Rainfall based on 100 Percent Capture of Excess Rainfall with and without the South Pasture Mine Extension

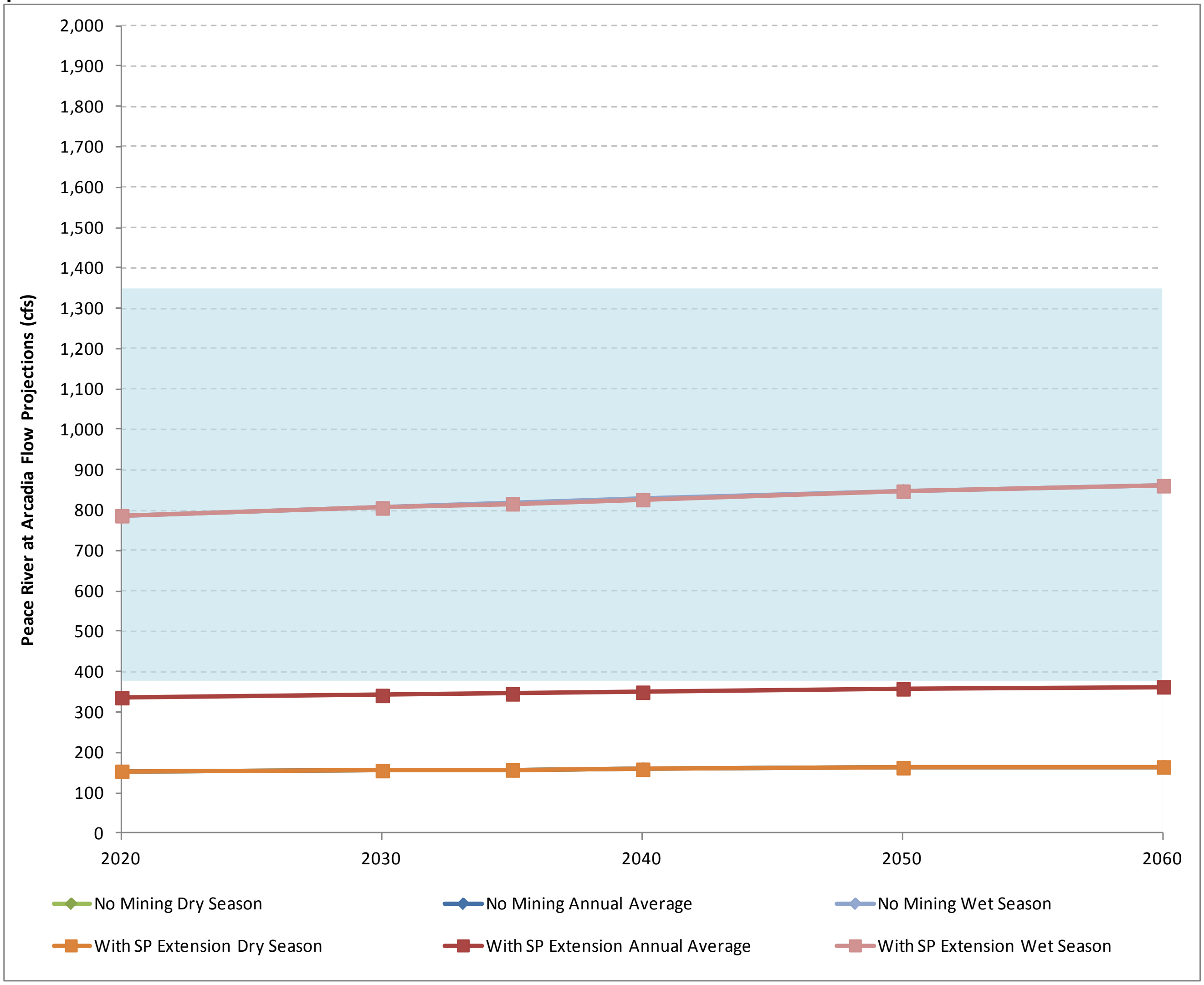
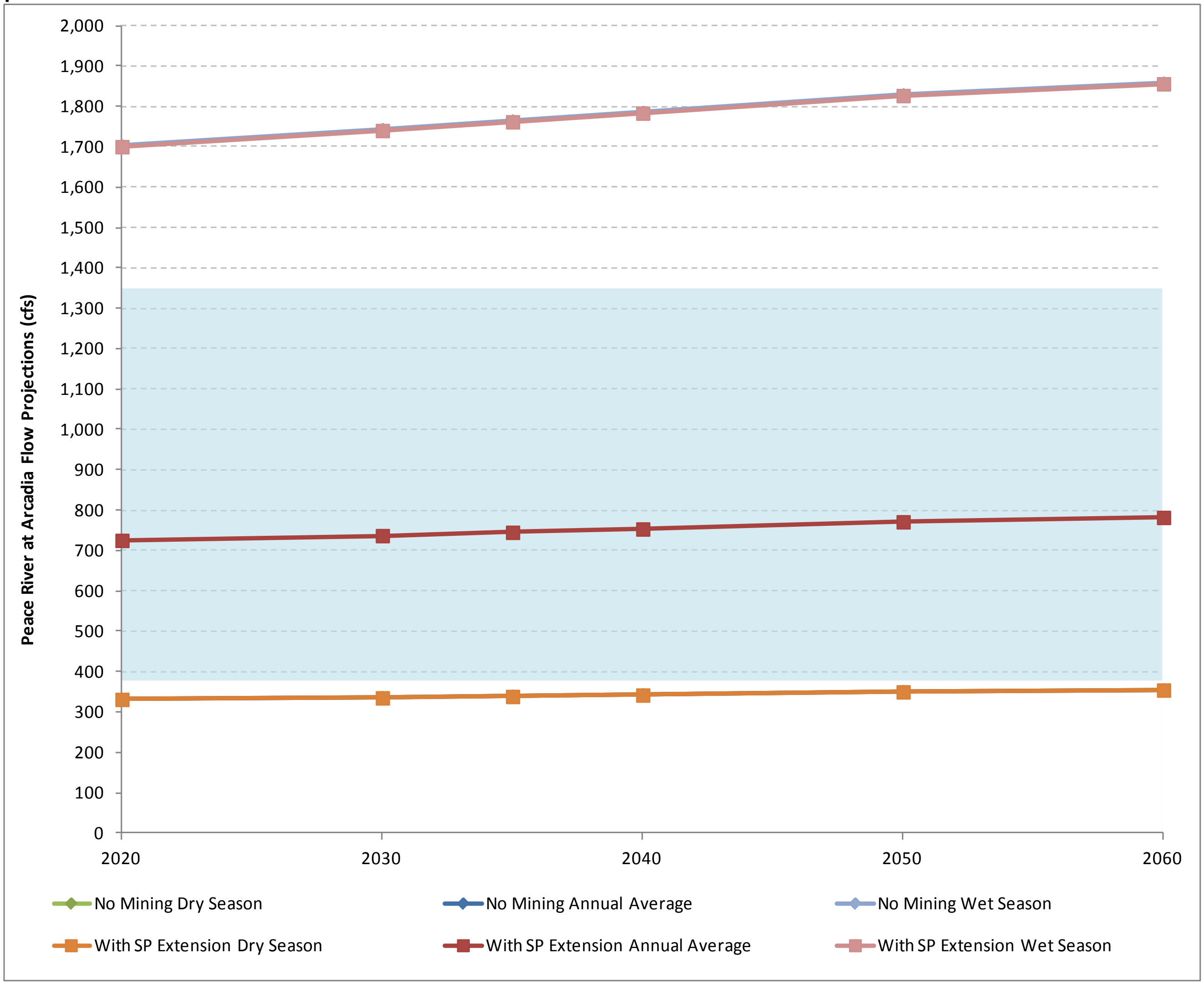


FIGURE 55

Peace River at Arcadia Annual Average and Seasonal Projected Flows for Average Annual Rainfall based on 50 Percent Capture of Excess Rainfall with and without the South Pasture Mine Extension



The largest influence on annual average flow from the Peace River at Arcadia subwatershed during average rainfall conditions are predicted to occur around 2030 based on the capture analysis. Based on 100 percent capture of stormwater, Peace River at Arcadia may have an average annual flow of approximately 738 cfs without the South Pasture Mine Extension and approximately 738 cfs with the South Pasture Mine Extension by 2030. No reductions in flow in this subwatershed resulting from mine capture are expected. Assuming a 50 percent capture of stormwater, Peace River at Arcadia may have an average annual flow of approximately 738 cfs as well, similar to the 100 percent capture case.

Figures 56 and 57 present the seasonal and annual average flows calculated for the Peace River at Arcadia gage station with and without the South Pasture Mine Extension based on 100 percent capture and 50 percent capture of stormwater, respectively, during low rainfall conditions.

FIGURE 56

Peace River at Arcadia Annual Average and Seasonal Projected Flows for Low Annual Rainfall based on 100 Percent Capture of Excess Rainfall with and without the South Pasture Mine Extension

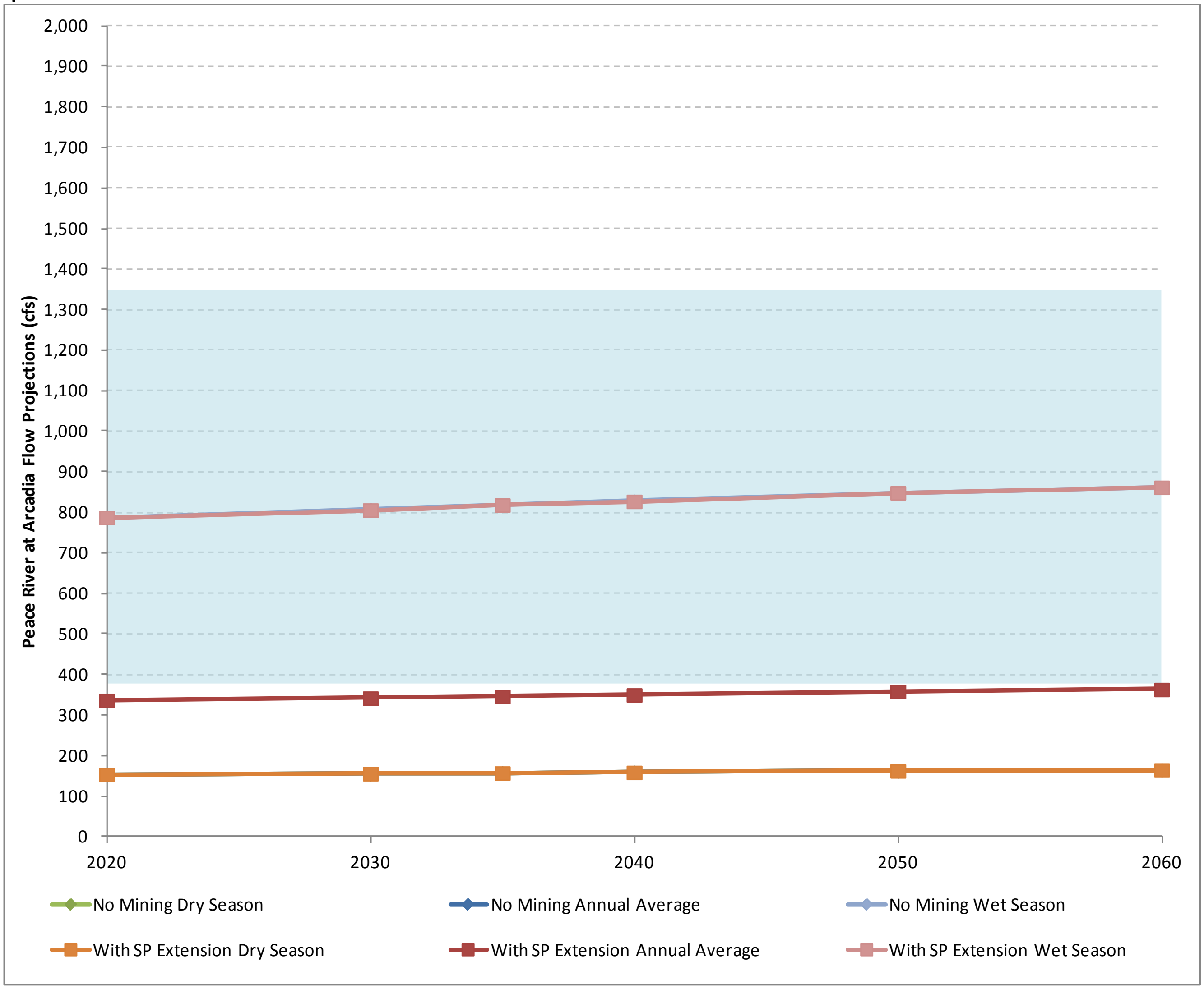
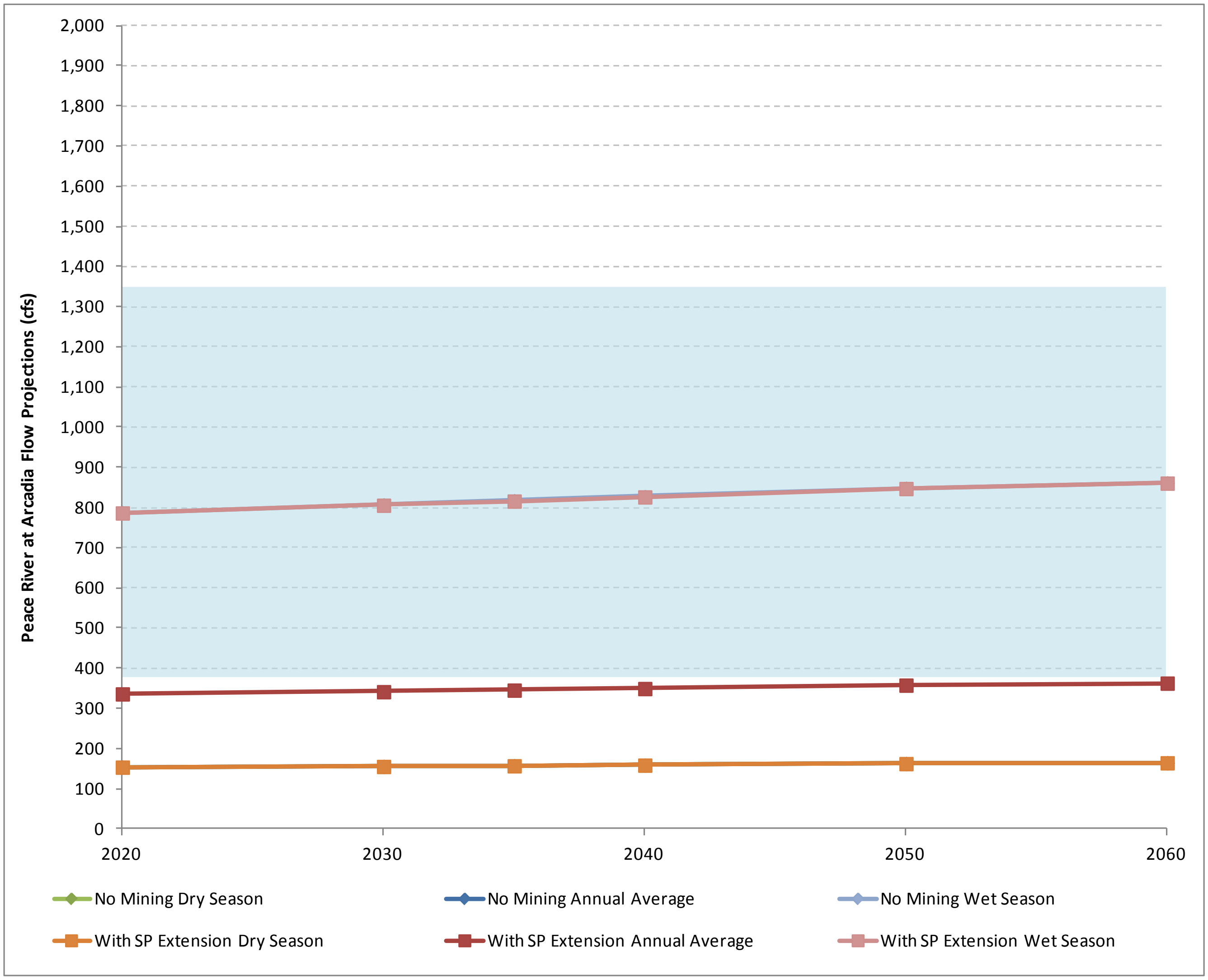


FIGURE 57
Peace River at Arcadia Annual Average and Seasonal Projected Flows for Low Annual Rainfall based on 50 Percent Capture of Excess Rainfall with and without South Pasture Mine Extension



Similar to average rainfall conditions, the largest influence on annual average flow from the Horse Creek subwatershed during low rainfall conditions was predicted to occur around 2030 based on the capture analysis. Based on 100 percent capture of stormwater Horse Creek may have an average annual flow of approximately 342 cfs without the South Pasture Mine Extension and the same approximate 342 cfs flow with the South Pasture Mine Extension by 2030. Assuming a 50 percent capture of stormwater, Horse Creek may have an average annual flow of approximately 342 cfs, similar to the 100 percent capture case.

The South Pasture Mine Extension would account for a small relative contribution to the flows measured at the Peace River at Arcadia gage station. The South Pasture Mine Extension effect on flow quantities at this station would likely not be perceivable, particularly since flows are expected to increase as a result of land use changes in the Peace River at Arcadia drainage area.

5.6 Pine Level/Keys Offsite Alternative Impacts on Runoff Characteristics and Stream Flow

The first part of this analysis looks at the potential direct and indirect effects of the Pine Level/Keys Tract as a stand-alone, offsite alternative. For the stand-alone analysis a start date of 2025 was assumed.

The second part of the analysis considers the Pine Level/Keys Tract as an extension of the Desoto Mine, with a start date of 2034. This was done for use later in the cumulative analysis which includes the Pine Level/Keys Tract as a reasonably foreseeable action.

5.6.1 Pine Level/Keys Tract Alternative Year 2025 Implementation

A portion of Pine Level/Keys is in Horse Creek, but most of the alternative is in the Big Slough subwatershed, which is part of the Lower Myakka River subwatershed. As with other alternatives, the potential effects of the capture of stormwater was analyzed for each subwatershed separately.

5.6.1.1 Pine Level/Keys Tract Year 2025 Implementation Effects on Big Slough

The Big Slough Basin drains toward the City of North Port and Myakkahatchee Creek, which joins the Myakka River very near where it flows into Charlotte Harbor. Therefore, this mine's drainage area would not influence flows in the Myakka River except as they contribute to Charlotte Harbor (for the cumulative effect analysis). Table 44 presents the flow and percent change from 2009 average annual and seasonal flows during an average rainfall year with 100 percent capture of stormwater in the capture area of the Pine Level/Keys Tract in Big Slough Basin. The maximum influence was predicted to occur between 2045 and 2050 according to the capture analysis. Annual average flow decreases by approximately 6 percent by 2050, dry season flow decreases by approximately 5 percent, and wet season flow decreases by approximately 5 percent from 2009 levels. Unlike the other alternatives studied, the annual flow rates were not estimated to increase in Big Slough Basin in this analysis from changes to future land use (because future land use predictions were not made here), but eventually the areas mined would be reclaimed and these potential flow reductions during active mining returned to near pre-mining conditions.

TABLE 44

Projected Flows and Percent Change from 2009 Flows during Average Rainfall Year and 100 Percent Capture in Big Slough Basin with the Pine Level/Keys Tract

	Annual Average Flow (cfs)	Annual Average Percent Change from 2009 Flows	Dry Season Average Flow (cfs)	Dry Season Percent Change from 2009 Flows	Wet Season Average Flow (cfs)	Wet Season Percent Change from 2009 Flows
2009	217	0%	117	0%	629	0%
2020	217	0%	117	0%	629	0%
2030	206	-5%	111	-5%	596	-5%
2040	207	-5%	111	-5%	599	-5%
2050	203	-6%	109	-7%	589	-6%
2060	215	-1%	116	-1%	623	-1%

Table 45 presents the flow and percent change from 2009 average annual and seasonal flows during an average rainfall year with 50 percent capture of stormwater in the capture area of the Pine Level/Keys Tract in Big Slough Basin. The maximum influence was predicted to occur between 2045 and 2050 based on the capture analysis. Annual average flow decreases by approximately 3 percent by 2050, dry season flow decreases by approximately 3 percent, and wet season flow decreases by approximately 3 percent from 2009 levels.

TABLE 45

Projected Flows and Percent Change from 2009 Flows during Average Rainfall Year and 50 Percent Capture in Big Slough Basin with the Pine Level/Keys Tract

	Annual Average Flow (cfs)	Annual Average Percent Change from 2009 Flows	Dry Season Average Flow (cfs)	Dry Season Percent Change from 2009 Flows	Wet Season Average Flow (cfs)	Wet Season Percent Change from 2009 Flows
2009	217	0%	117	0%	629	0%
2020	217	0%	117	0%	629	0%
2030	212	-3%	114	-3%	613	-3%
2040	212	-2%	114	-2%	614	-2%
2050	210	-3%	113	-3%	609	-3%
2060	216	<-1%	116	<-1%	626	<-1%

The same evaluation was performed for a low rainfall year. Table 46 presents the flow and percent change from 2009 average annual and seasonal flows during a low rainfall year with 100 percent capture of stormwater in the capture area of the Pine Level/Keys Tract. The maximum influence is predicted to occur between 2045 and 2050 based on the capture analysis. Flows are predicted to decrease during the Pine Level/Keys Tract mining period. Annual average flow decreases by approximately 6 percent by 2050, dry season flow decreases by approximately 7 percent, and wet season flow decreases by approximately 6 percent from 2009 levels.

TABLE 46

Projected Flows and Percent Change from 2009 Flows during Low Rainfall Year and 100 Percent Capture in Big Slough Basin with the Pine Level/Keys Tract

	Annual Average Flow (cfs)	Annual Average Percent Change from 2009 Flows	Dry Season Average Flow (cfs)	Dry Season Percent Change from 2009 Flows	Wet Season Average Flow (cfs)	Wet Season Percent Change from 2009 Flows
2009	176	0%	95	0%	511	0%
2020	176	0%	95	0%	511	0%
2030	167	-5%	90	-5%	484	-5%
2040	168	-5%	90	-5%	486	-5%
2050	165	-6%	89	-7%	478	-6%
2060	175	-1%	94	-1%	506	-1%

Table 47 presents the flow and percent change from 2009 average annual and seasonal flows during a low rainfall year with 50 percent capture of stormwater in the capture area of the Pine Level/Keys Tract. The maximum influence was predicted to occur between 2045 and 2050 based on the capture analysis. Similar to the average rainfall year scenario, annual average flow decreases by approximately 3 percent by 2050, dry season flow decreases by approximately 3 percent, and wet season flow decreases by approximately 3 percent from 2009 levels.

TABLE 47

Projected Flows and Percent Change from 2009 Flows during Low Rainfall Year and 50 Percent in Big Slough Basin with the Pine Level/Keys Tract

	Annual Average Flow (cfs)	Annual Average Percent Change from 2009 Flows	Dry Season Average Flow (cfs)	Dry Season Percent Change from 2009 Flows	Wet Season Average Flow (cfs)	Wet Season Percent Change from 2009 Flows
2009	176	0%	95	0%	511	0%
2020	176	0%	95	0%	511	0%
2030	172	-3%	92	-3%	497	-3%
2040	172	-2%	92	-2%	498	-2%
2050	171	-3%	92	-3%	494	-3%
2060	176	0%	94	<-1%	508	<-1%

To illustrate the effect on Big Slough Basin stream flow under the conditions and scenarios evaluated, the results are presented graphically and compared to the No Action Alternative conditions. Figures 58 and 59 present the seasonal and annual average flows calculated for Big Slough Basin with and without the Pine Level/Keys Tract based on 100 percent capture and 50 percent capture of stormwater, respectively, during average rainfall conditions. The range of one standard deviation was not plotted because sufficient flow data were not available for this subwatershed.

FIGURE 58

Big Slough Basin Annual Average and Seasonal Projected Flows for Average Annual Rainfall based on 100 Percent Capture of Excess Rainfall with and without the Pine Level/Keys Tract

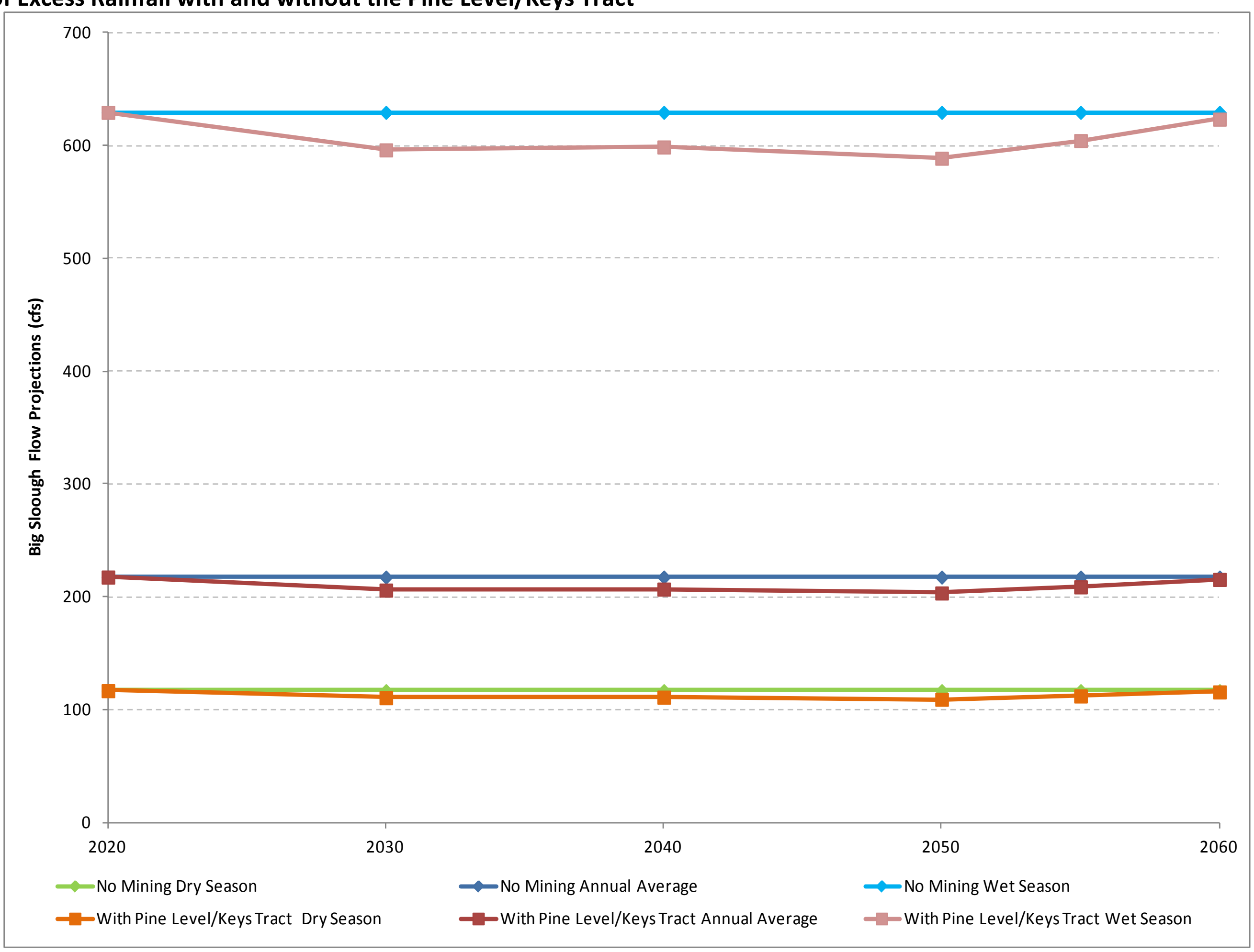
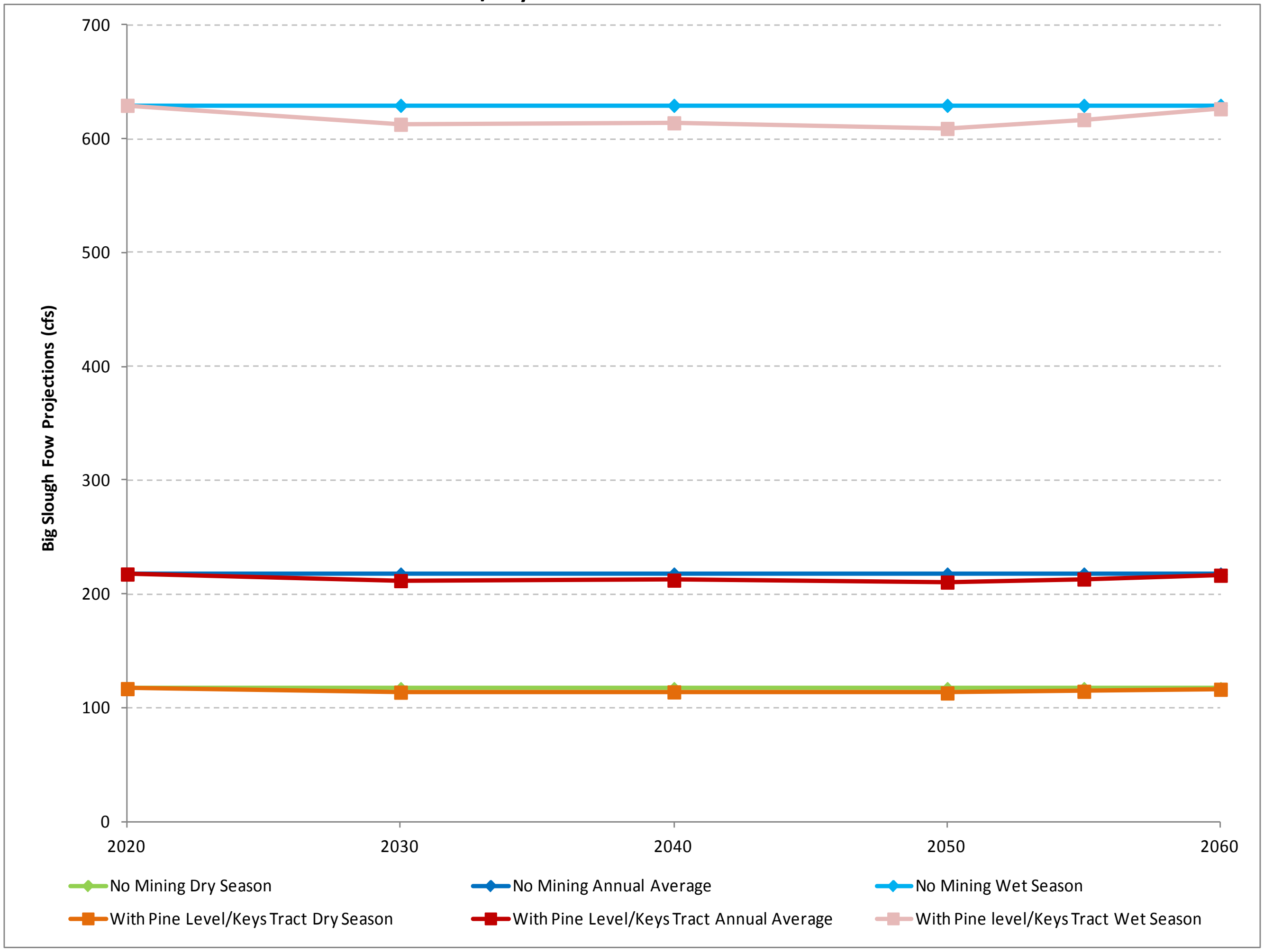


FIGURE 59

Big Slough Basin Annual Average and Seasonal Projected Flows for Average Annual Rainfall based on 50 Percent Capture of Excess Rainfall with and without the Pine Level/Keys Tract



The largest influence on annual average flow from the upper Myakka River subwatershed during average rainfall conditions is predicted to occur 2050 based on the capture analysis. Based on 100 percent capture of stormwater, Big Slough Basin may have an average annual flow of approximately 217 cfs without the Pine Level/Keys Tract and approximately 203 cfs with the Pine Level/Keys Tract during that period. Assuming a 50 percent capture of stormwater, Big Slough Basin may have an average annual flow of approximately 210 cfs. This corresponds to a decrease in flow of 7 cfs when compared to the No Action Alternative conditions.

Figures 60 and 61 present the seasonal and annual average flows calculated for Big Slough Basin with and without the Pine Level/Keys Tract based on 100 percent capture and 50 percent capture of stormwater, respectively, during low rainfall conditions.

FIGURE 60

Big Slough Basin Annual Average and Seasonal Projected Flows for Low Annual Rainfall based on 100 Percent Capture of Excess Rainfall with and without Pine Level/Keys Tract

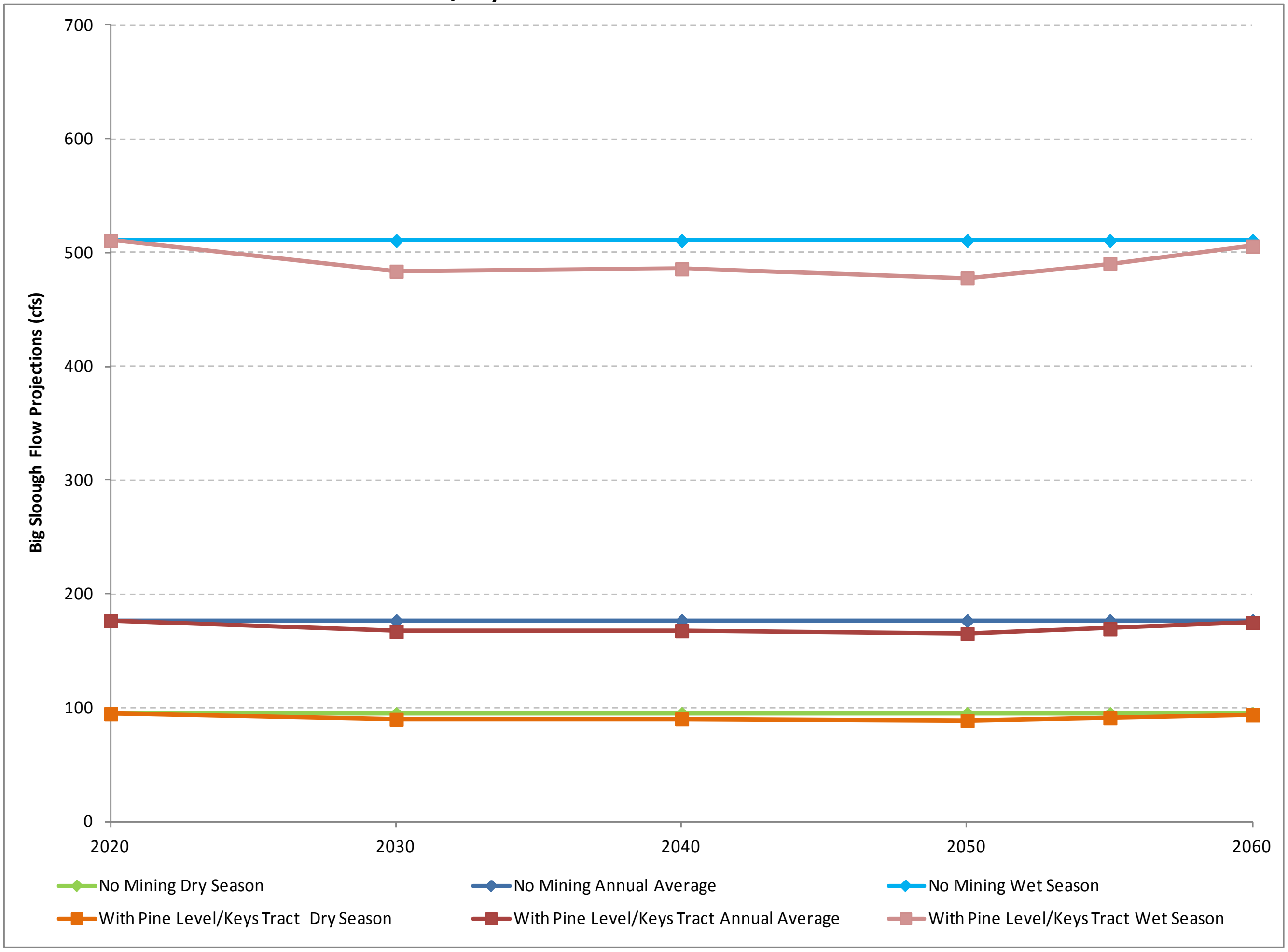
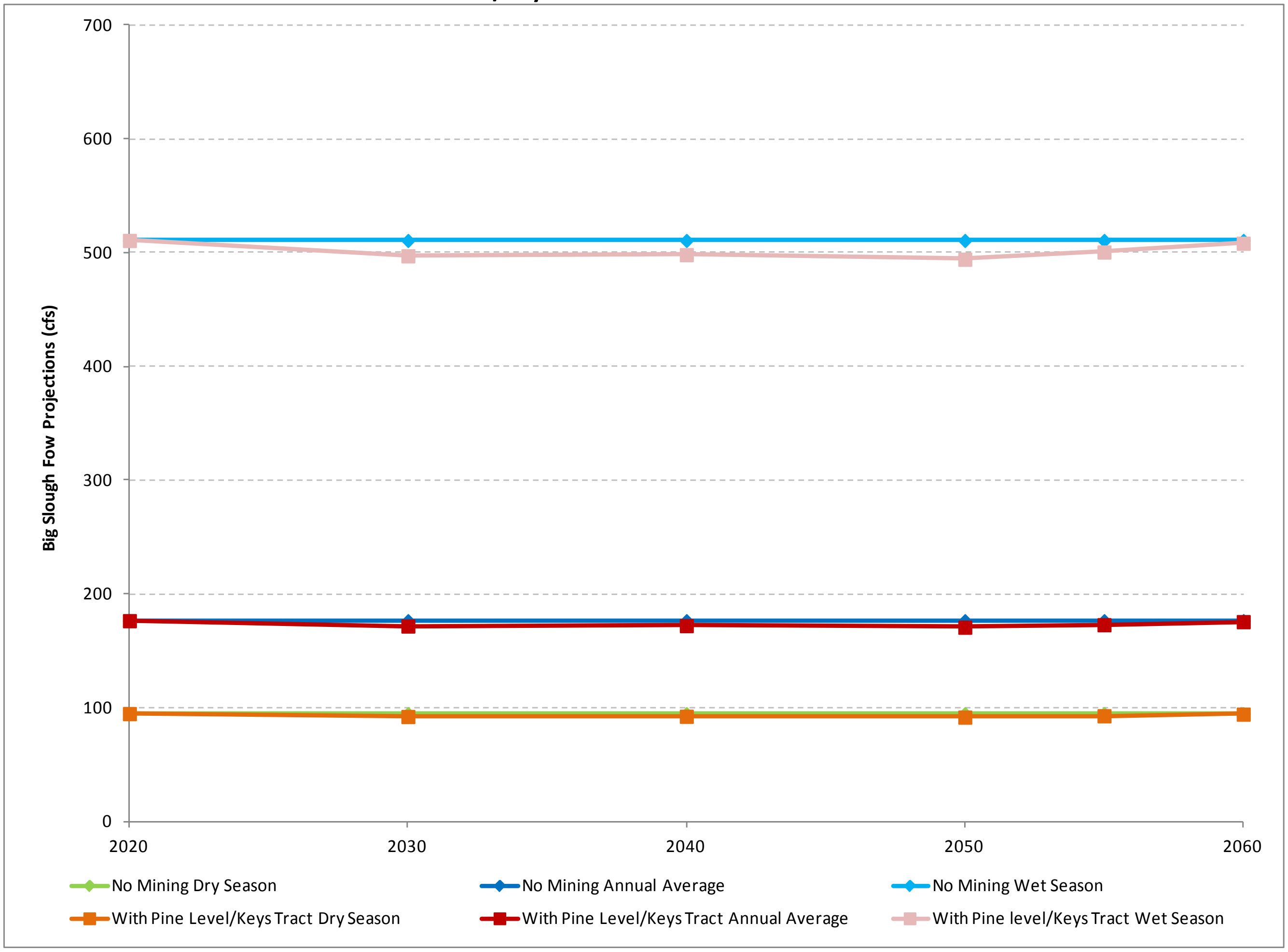


FIGURE 61

Big Slough Basin Annual Average and Seasonal Projected Flows for Low Annual Rainfall based on 50 Percent Capture of Excess Rainfall with and without the Pine Level/Keys Tract



Similar to average rainfall conditions, the largest influence on annual average flow from the Big Slough Basin during low rainfall conditions was predicted to occur around 2050. Based on 100 percent capture of stormwater, the Big Slough Basin may have an average annual flow of approximately 176 cfs without the Pine Level/Keys Tract, and approximately 165 cfs with the Pine Level/Keys Tract. Assuming a 50 percent capture of stormwater, the Big Slough Basin may have an average annual flow of approximately 171 cfs. This corresponds to a decrease in flow of 5 cfs. The Pine Level/Keys Tract effects on flow quantities in Big Slough Basin would likely be relatively small, most perceptible during high flow periods, and projected far into the future. The SWFWMD plans to revisit the flows in this watershed in more detail after more data are collected near the City of North Port.

5.6.1.2 Pine Level/Keys Tract Year 2025 Implementation Effects on Horse Creek

A portion of the Pine Level/Keys Tract (about 3,480 acres) drains into the Horse Creek subwatershed. Table 48 presents the flow and percent change from 2009 average annual and seasonal flows during an average rainfall year with 100 percent capture of stormwater in the capture area of the Pine Level/Keys Tract in Horse Creek subwatershed. The maximum influence was predicted to occur around 2040 according to the capture analysis. Annual average flow increases by approximately 1 percent by 2040, dry season flow increases less than 1 percent, and wet season flow increases by approximately 2 percent from 2009 levels. Eventually the areas mined would be reclaimed and these potential flow reductions during active mining returned to near pre-mining conditions.

TABLE 48

Projected Flows and Percent Change from 2009 Flows during Average Rainfall Year and 100 Percent Capture in Horse Creek Flow Station with the Pine Level/Keys Tract

	Annual Average Flow (cfs)	Annual Average Percent Change from 2009 Flows	Dry Season Average Flow (cfs)	Dry Season Percent Change from 2009 Flows	Wet Season Average Flow (cfs)	Wet Season Percent Change from 2009 Flows
2009	171	0%	78	0%	404	0%
2020	173	1%	78	0%	413	2%
2030	173	1%	78	0%	416	3%
2040	172	1%	77	<1%	414	2%
2050	173	1%	78	0%	417	3%
2060	176	3%	79	2%	424	5%

Table 49 presents the flow and percent change from 2009 average annual and seasonal flows during an average rainfall year with 50 percent capture of stormwater in the capture area of the Pine Level/Keys Tract in Horse Creek subwatershed. The maximum influence was predicted to occur around 2040 based on the capture analysis. Annual average flow increases by approximately 1 percent by 2040, dry season flow remains about the same, and wet season flow increases by approximately 3 percent from 2009 levels.

TABLE 49

Projected Flows and Percent Change from 2009 Flows during Average Rainfall Year and 50 Percent Capture in Horse Creek Flow Station with the Pine Level/Keys Tract

	Annual Average Flow (cfs)	Annual Average Percent Change from 2009 Flows	Dry Season Average Flow (cfs)	Dry Season Percent Change from 2009 Flows	Wet Season Average Flow (cfs)	Wet Season Percent Change from 2009 Flows
2009	171	0%	78	0%	404	0%
2020	173	1%	78	0%	413	2%
2030	173	1%	78	0%	416	3%
2040	173	1%	78	0%	417	3%
2050	174	2%	78	<1%	419	4%
2060	176	3%	79	2%	424	5%

The same evaluation was performed for a low rainfall year. Table 50 presents the flow and percent change from 2009 average annual and seasonal flows during a low rainfall year with 100 percent capture of stormwater in the capture area of the Pine Level/Keys Tract. The maximum influence was predicted to occur around 2040 based on the capture analysis. Annual average flow increases by approximately 1 percent by 2040, dry season flow remains about the same, and wet season flow increases by approximately 2 percent from 2009 levels.

TABLE 50

Projected Flows and Percent Change from 2009 Flows during Low Rainfall Year and 100 Percent Capture Horse Creek Flow Station with the Pine Level/Keys Tract

	Annual Average Flow (cfs)	Annual Average Percent Change from 2009 Flows	Dry Season Average Flow (cfs)	Dry Season Percent Change from 2009 Flows	Wet Season Average Flow (cfs)	Wet Season Percent Change from 2009 Flows
2009	84	0%	38	0%	199	0%
2020	85	1%	38	0%	203	2%
2030	85	1%	38	0%	204	3%
2040	85	1%	38	0%	204	2%
2050	85	1%	38	0%	205	3%
2060	87	3%	39	2%	208	5%

Table 51 presents the flow and percent change from 2009 average annual and seasonal flows during a low rainfall year with 50 percent capture of stormwater in the capture area of the Pine Level/Keys Tract. The maximum influence was predicted to occur around 2040 based on the capture analysis. Annual average flow increases by approximately 1 percent by 2040, dry season flow remains about the same, and wet season flow increases by approximately 3 percent from 2009 levels.

TABLE 51

Projected Flows and Percent Change from 2009 Flows during Low Rainfall Year and 50 Percent Horse Creek Flow Station with the Pine Level/Keys Tract

	Annual Average Flow (cfs)	Annual Average Percent Change from 2009 Flows	Dry Season Average Flow (cfs)	Dry Season Percent Change from 2009 Flows	Wet Season Average Flow (cfs)	Wet Season Percent Change from 2009 Flows
2009	84	0%	38	0%	199	0%
2020	85	1%	38	0%	203	2%
2030	85	1%	38	0%	204	3%
2040	85	1%	38	0%	205	3%
2050	86	2%	39	1%	206	4%
2060	87	3%	39	2%	208	5%

To illustrate the effect on Horse Creek subwatershed stream flow under the conditions and scenarios evaluated, the results are presented graphically and compared to the No Action Alternative conditions. Figures 62 and 63 present the seasonal and annual average flows calculated for Horse Creek subwatershed with and without the Pine Level/Keys Tract based on 100 percent capture and 50 percent capture of stormwater, respectively, during average rainfall conditions.

FIGURE 62

Horse Creek Annual Average and Seasonal Projected Flows for Average Annual Rainfall based on 100 Percent Capture of Excess Rainfall with and without the Pine Level/Keys Tract

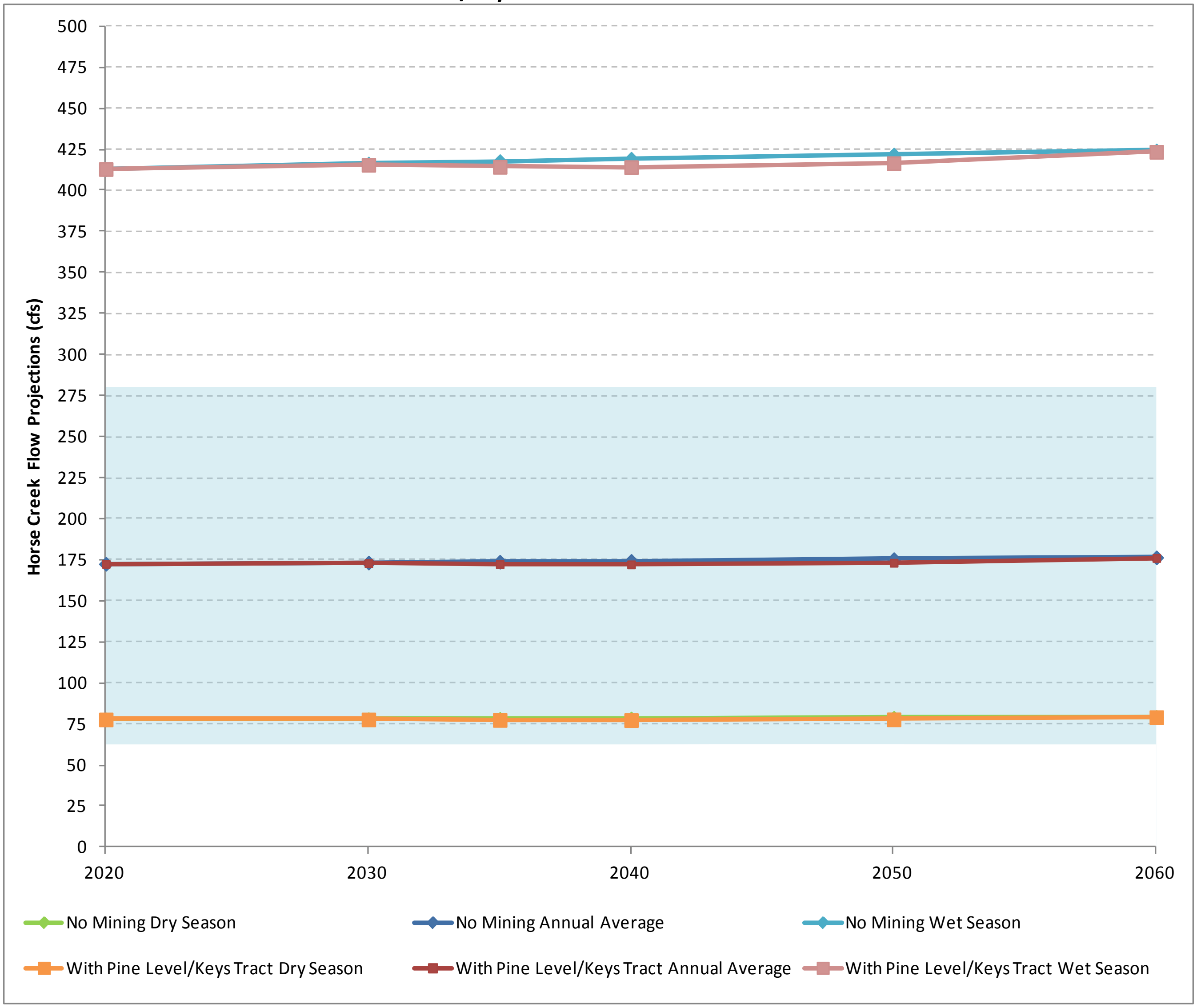
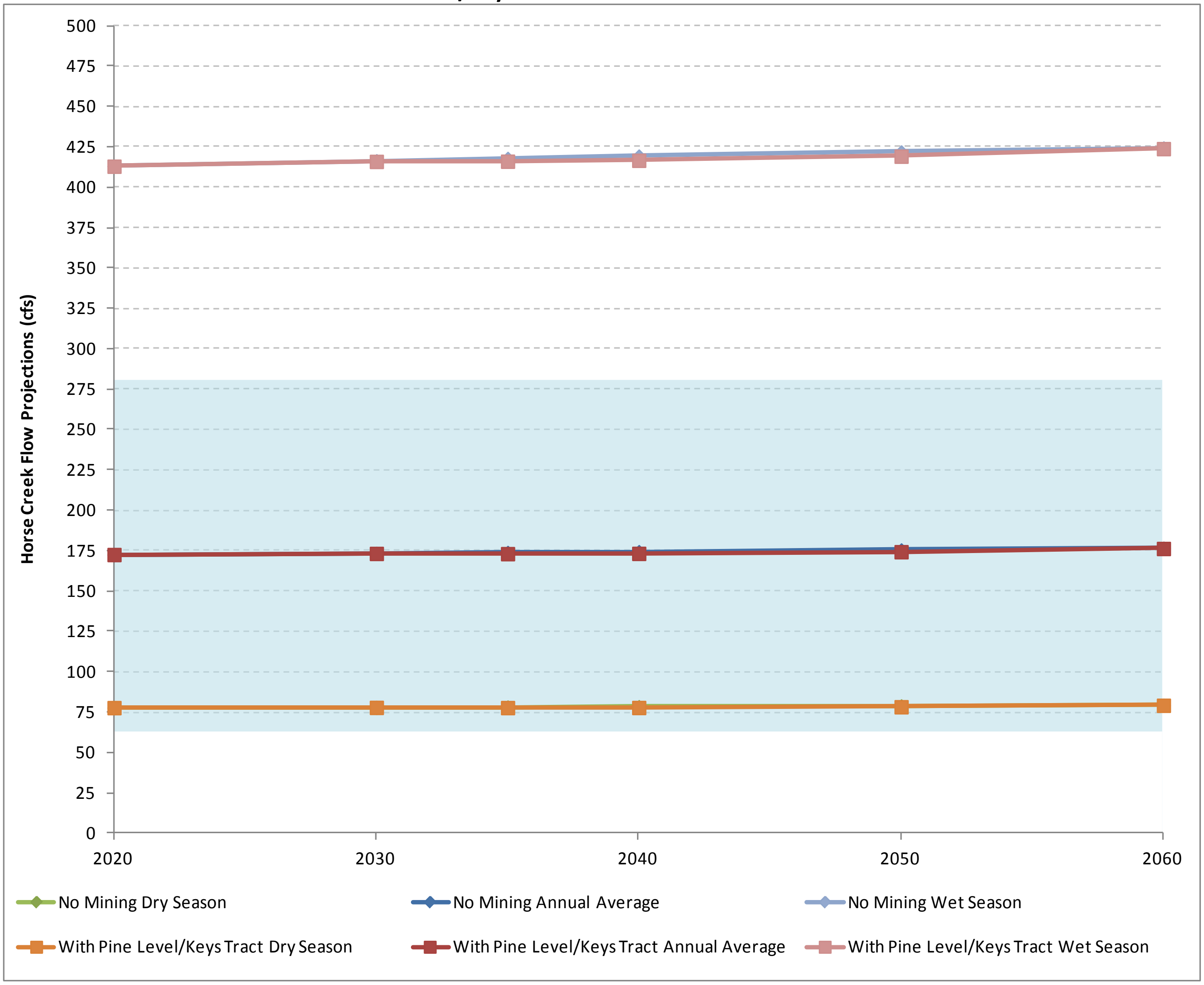


FIGURE 63

Horse Creek Annual Average and Seasonal Projected Flows for Average Annual Rainfall based on 50 Percent Capture of Excess Rainfall with and without the Pine Level/Keys Tract



The largest influence on annual average flow from the Horse Creek subwatershed during average rainfall conditions is predicted to occur 2040 based on the capture analysis. Based on 100 percent capture of stormwater, Horse Creek subwatershed may have an average annual flow of approximately 174 cfs without the Pine Level/Keys Tract and approximately 172 cfs with the Pine Level/Keys Tract during that period. Assuming a 50 percent capture of stormwater, Horse Creek subwatershed may have an average annual flow of approximately 173 cfs. This corresponds to a decrease in flow of 1 cfs when compared to the No Action Alternative conditions.

Figures 64 and 65 present the seasonal and annual average flows calculated for Horse Creek subwatershed with and without the Pine Level/Keys Tract based on 100 percent capture and 50 percent capture of stormwater, respectively, during low rainfall conditions.

FIGURE 64

Horse Creek Annual Average and Seasonal Projected Flows for Low Annual Rainfall based on 100 Percent Capture of Excess Rainfall with and without Pine Level/Keys Tract

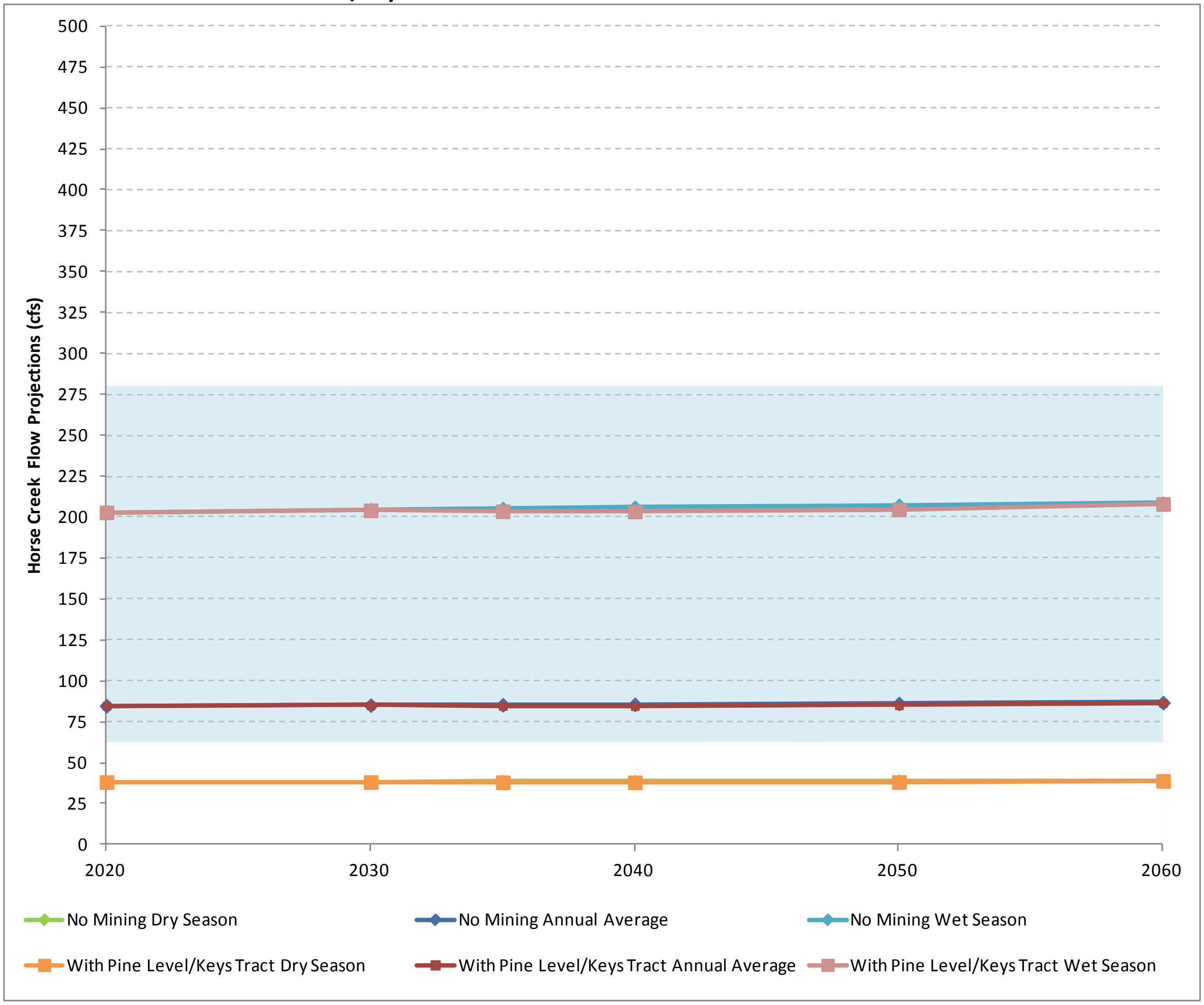
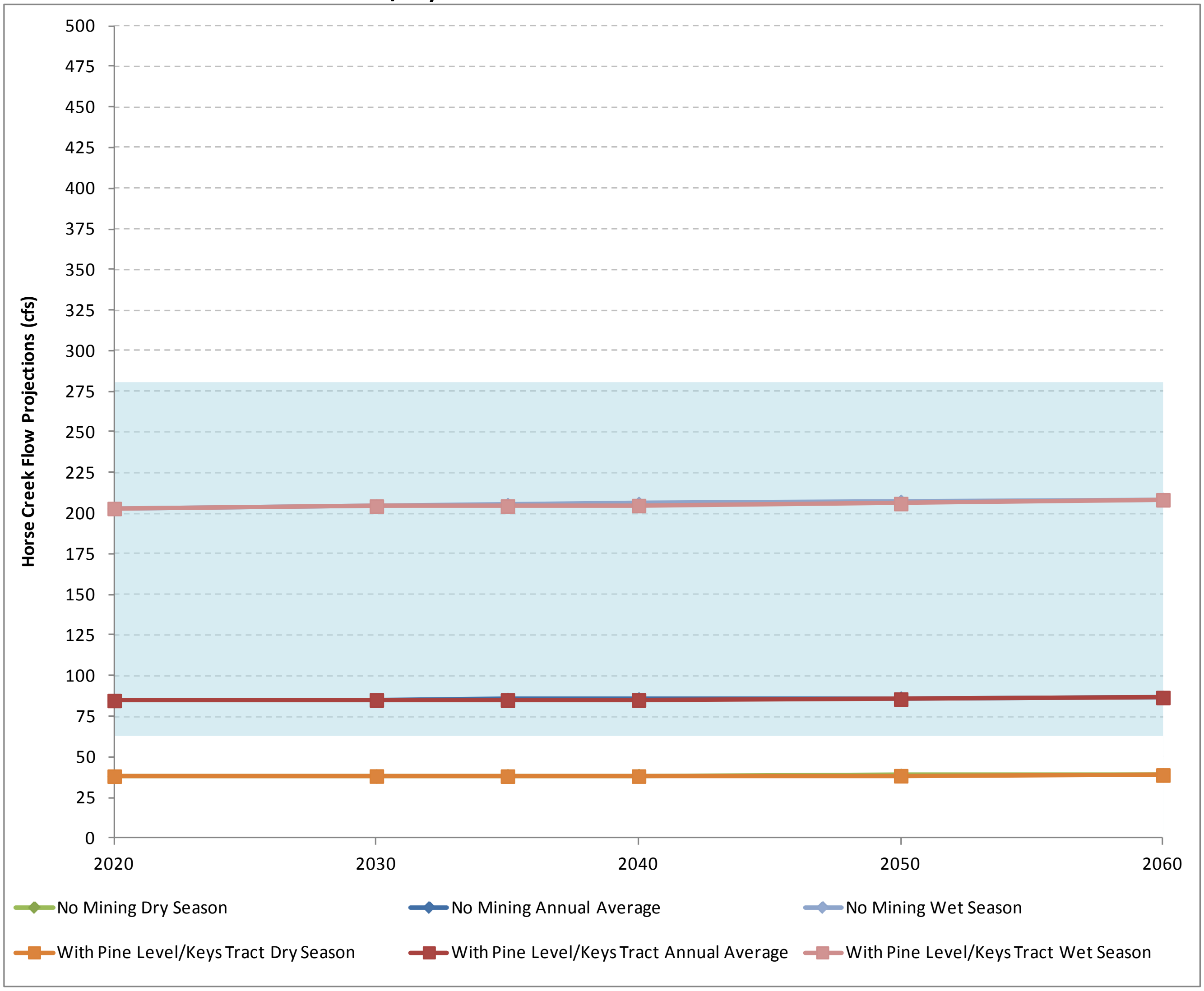


FIGURE 65
Horse Creek Annual Average and Seasonal Projected Flows for Low Annual Rainfall based on 50 Percent Capture of Excess Rainfall with and without the Pine Level/Keys Tract



Similar to average rainfall conditions, the largest influence on annual average flow from the Horse Creek subwatershed during low rainfall conditions was predicted to occur around 2040. Based on 100 percent capture of stormwater, the Horse Creek subwatershed may have an average annual flow of approximately 86 cfs without the Pine Level/Keys Tract, and approximately 85 cfs with the Pine Level/Keys Tract. Assuming a 50 percent capture of stormwater, the Horse Creek subwatershed may have an average annual flow of approximately 85 cfs. This corresponds to a decrease in flow of 1 cfs.

5.6.2 Pine Level/Keys Tract Alternative Year 2034 Implementation

5.6.2.1 Pine Level/Keys Tract Year 2034 Implementation Effects on Big Slough

Table 52 presents the flow and percent change from 2009 average annual and seasonal flows during an average rainfall year with 100 percent capture of stormwater in the capture area of the Pine Level/Keys Tract in Big Slough Basin. The capture curves indicate that the most area under surface water management controls at this alternative is around 2055 for the Big Slough subwatershed. Therefore, an additional analysis was conducted to evaluate the near peak capture conditions. Annual average flow decreases by approximately 7 percent by 2055, dry season flow decreases by approximately 7 percent, and wet season flow decreases by approximately 7 percent from 2009 levels. Unlike the other alternatives studied, the annual flow rates were not increased in Big

Slough Basin in this analysis from changes to future land use, but eventually the areas mined would be reclaimed and these potential flow reductions during active mining returned to near pre-mining conditions.

TABLE 52

Projected Flows and Percent Change from 2009 Flows during Average Rainfall Year and 100 Percent Capture in Big Slough Basin with the Pine Level/Keys Tract

	Annual Average Flow (cfs)	Annual Average Percent Change from 2009 Flows	Dry Season Average Flow (cfs)	Dry Season Percent Change from 2009 Flows	Wet Season Average Flow (cfs)	Wet Season Percent Change from 2009 Flows
2009	217	0%	117	0%	629	0%
2020	217	0%	117	0%	629	0%
2030	217	0%	117	0%	629	0%
2040	206	-5%	111	-5%	596	-5%
2050	207	-5%	111	-5%	599	-5%
2055	202	-7%	108	-7%	584	-7%
2060	203	-6%	109	-7%	589	-6%

Table 53 presents the flow and percent change from 2009 average annual and seasonal flows during an average rainfall year with 50 percent capture of stormwater in the capture area of the Pine Level/Keys Tract in Big Slough Basin. The maximum influence was predicted to occur around 2055 based on the capture analysis. Annual average flow decreases by approximately 4 percent by 2055, dry season flow decreases by approximately 4 percent, and wet season flow decreases by approximately 4 percent from 2009 levels.

TABLE 53

Projected Flows and Percent Change from 2009 Flows during Average Rainfall Year and 50 Percent Capture in Big Slough Basin with the Pine Level/Keys Tract

	Annual Average Flow (cfs)	Annual Average Percent Change from 2009 Flows	Dry Season Average Flow (cfs)	Dry Season Percent Change from 2009 Flows	Wet Season Average Flow (cfs)	Wet Season Percent Change from 2009 Flows
2009	217	0%	117	0%	629	0%
2020	217	0%	117	0%	629	0%
2030	217	0%	117	0%	629	0%
2040	212	-3%	114	-3%	613	-3%
2050	212	-2%	114	-2%	614	-2%
2055	210	-4%	113	-4%	607	-4%
2060	210	-3%	113	-3%	609	-3%

The same evaluation was performed for a low rainfall year. Table 54 presents the flow and percent change from 2009 average annual and seasonal flows during a low rainfall year with 100 percent capture of stormwater in the capture area of the Pine Level/Keys Tract. The maximum influence is predicted to occur around 2055 based on the capture analysis. Flows are predicted to decrease during the Pine Level/Keys Tract mining period. Annual average flow decreases by approximately 7 percent by 2055, dry season flow decreases by approximately 7 percent, and wet season flow decreases by approximately 7 percent from 2009 levels.

TABLE 54

Projected Flows and Percent Change from 2009 Flows during Low Rainfall Year and 100 Percent Capture in Big Slough Basin with the Pine Level/Keys Tract

	Annual Average Flow (cfs)	Annual Average Percent Change from 2009 Flows	Dry Season Average Flow (cfs)	Dry Season Percent Change from 2009 Flows	Wet Season Average Flow (cfs)	Wet Season Percent Change from 2009 Flows
2009	176	0%	95	0%	511	0%
2020	176	0%	95	0%	511	0%
2030	176	0%	95	0%	511	0%
2040	167	-5%	90	-5%	484	-5%
2050	168	-5%	90	-5%	486	-5%
2055	164	-7%	88	-7%	474	-7%
2060	165	-6%	89	-7%	478	-6%

Table 55 presents the flow and percent change from 2009 average annual and seasonal flows during a low rainfall year with 50 percent capture of stormwater in the capture area of the Pine Level/Keys Tract. The maximum influence was predicted to occur around 2055 based on the capture analysis. Similar to the average rainfall year scenario, annual average flow decreases by approximately 4 percent by 2055, dry season flow decreases by approximately 4 percent, and wet season flow increases by approximately 4 percent from 2009 levels.

TABLE 55

Projected Flows and Percent Change from 2009 Flows during Low Rainfall Year and 50 Percent in Big Slough Basin with the Pine Level/Keys Tract

	Annual Average Flow (cfs)	Annual Average Percent Change from 2009 Flows	Dry Season Average Flow (cfs)	Dry Season Percent Change from 2009 Flows	Wet Season Average Flow (cfs)	Wet Season Percent Change from 2009 Flows
2009	176	0%	95	0%	511	0%
2020	176	0%	95	0%	511	0%
2030	176	0%	95	0%	511	0%
2040	172	-3%	92	-3%	497	-3%
2050	172	-2%	92	-2%	498	-2%
	170	-4%	91	-4%	492	-4%
2060	171	-3%	92	-3%	494	-3%

To illustrate the effect on Big Slough Basin stream flow under the conditions and scenarios evaluated, the results are presented graphically and compared to the No Action Alternative conditions. Figures 66 and 67 present the seasonal and annual average flows calculated for Big Slough Basin with and without the Pine Level/Keys Tract based on 100 percent capture and 50 percent capture of stormwater, respectively, during average rainfall conditions.

FIGURE 66

Big Slough Basin Annual Average and Seasonal Projected Flows for Average Annual Rainfall based on 100 Percent Capture of Excess Rainfall with and without the Pine Level/Keys Tract

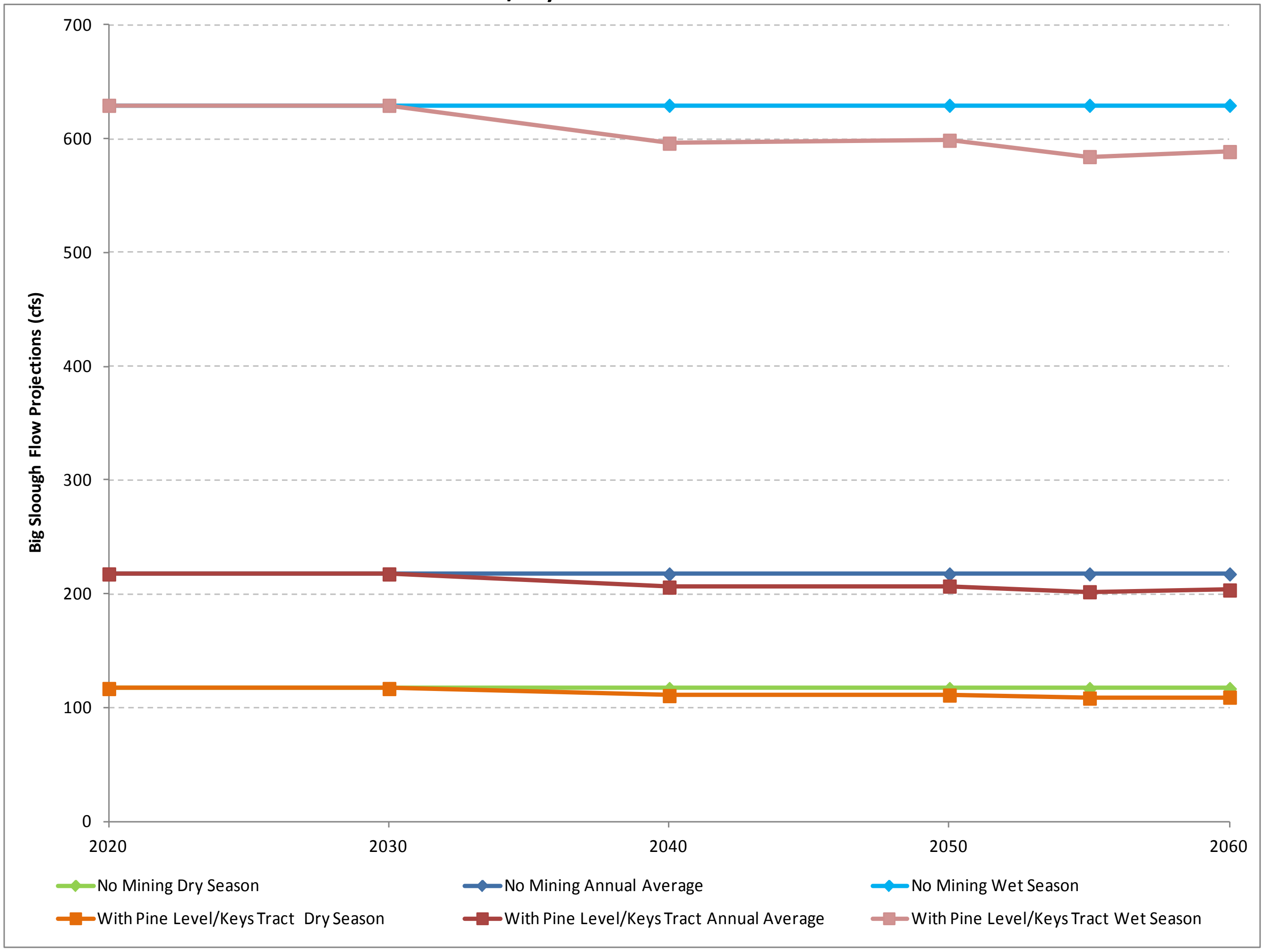
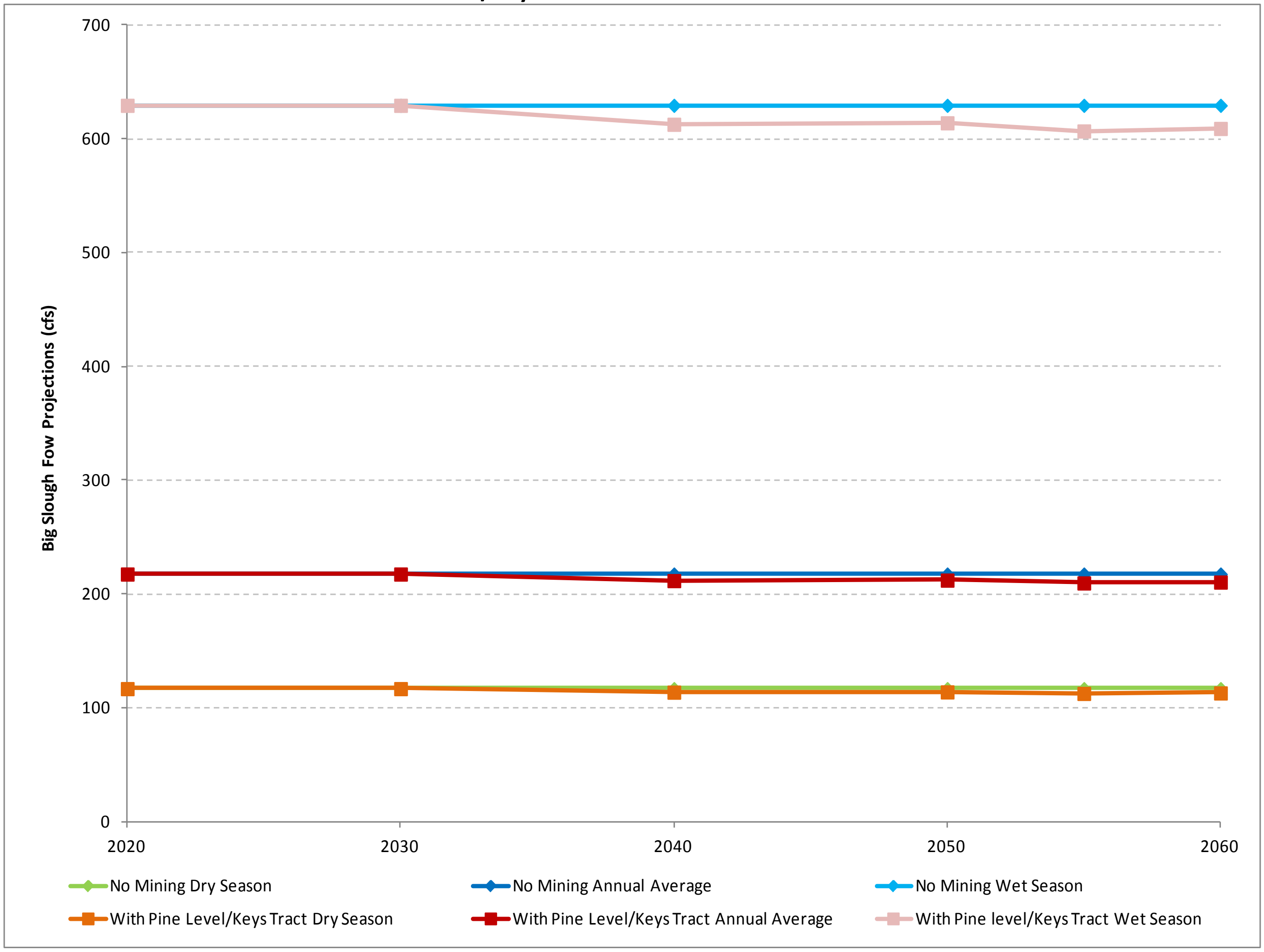


FIGURE 67

Big Slough Basin Annual Average and Seasonal Projected Flows for Average Annual Rainfall based on 50 Percent Capture of Excess Rainfall with and without the Pine Level/Keys Tract



The largest influence on annual average flow from the upper Myakka River subwatershed during average rainfall conditions is predicted to occur around 2055 based on the capture analysis. Based on 100 percent capture of stormwater, Big Slough Basin may have an average annual flow of approximately 217 cfs without the Pine Level/Keys Tract and approximately 202 cfs with the Pine Level/Keys Tract by 2055. Assuming a 50 percent capture of stormwater, Big Slough Basin may have an average annual flow of approximately 210 cfs. This corresponds to a decrease in flow of 7 cfs when compared to the No Action Alternative conditions.

Figures 68 and 69 present the seasonal and annual average flows calculated for Big Slough Basin with and without the Pine Level/Keys Tract based on 100 percent capture and 50 percent capture of stormwater, respectively, during low rainfall conditions.

FIGURE 68

Big Slough Basin Annual Average and Seasonal Projected Flows for Low Annual Rainfall based on 100 Percent Capture of Excess Rainfall with and without Pine Level/Keys Tract

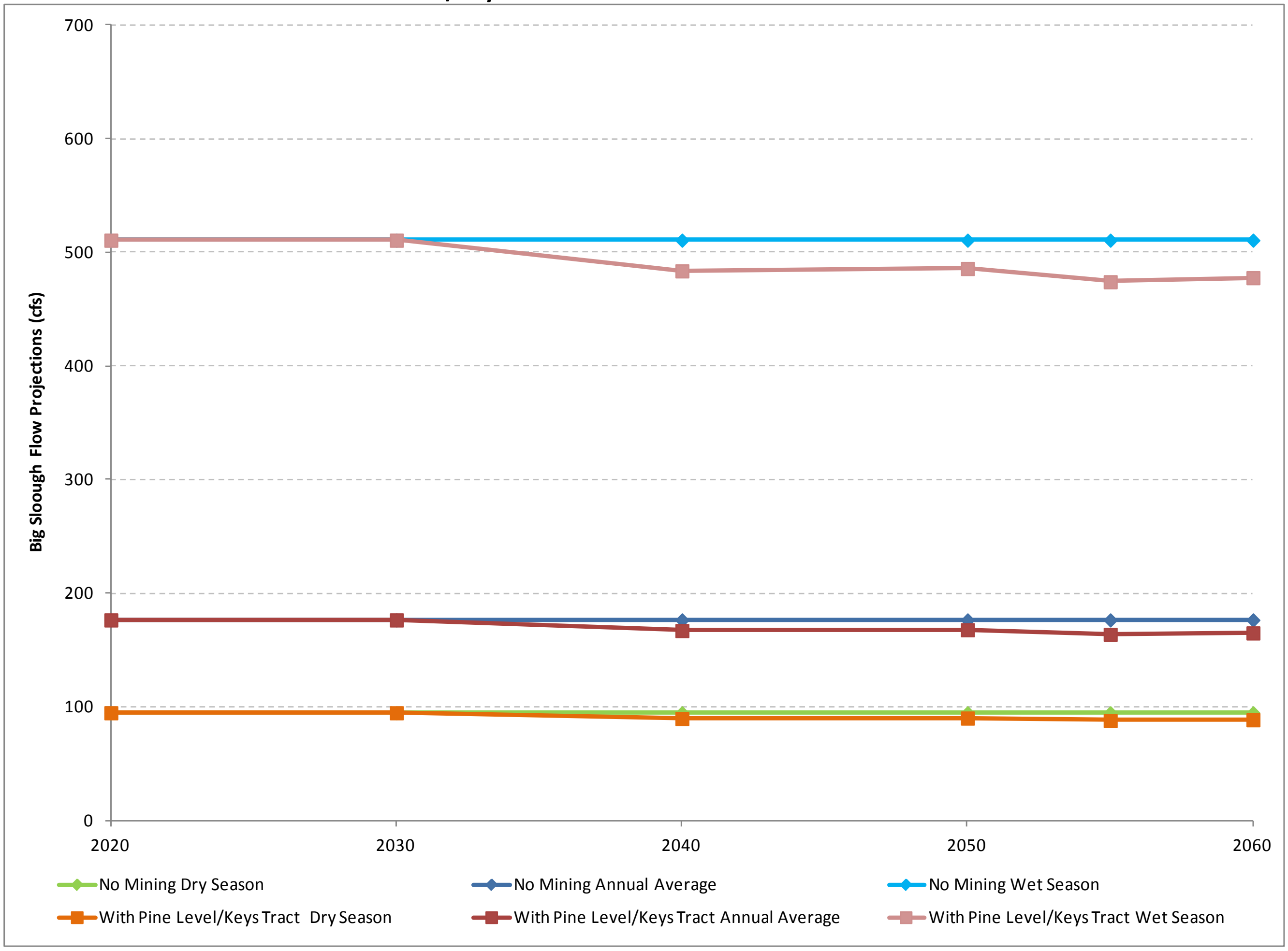
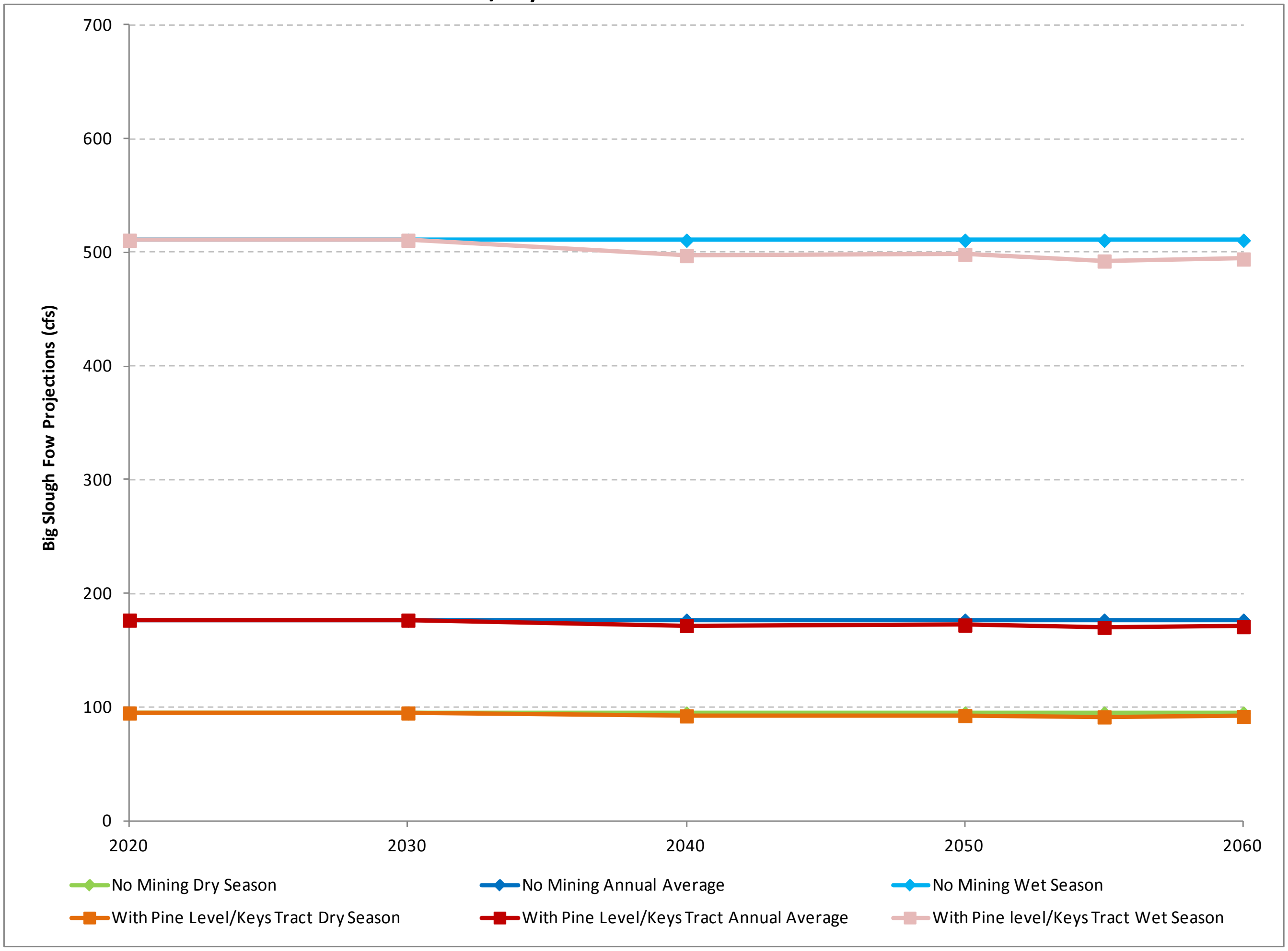


FIGURE 69
Big Slough Basin Annual Average and Seasonal Projected Flows for Low Annual Rainfall based on 50 Percent Capture of Excess Rainfall with and without the Pine Level/Keys Tract



Similar to average rainfall conditions, the largest influence on annual average flow from the Big Slough Basin during low rainfall conditions was predicted to occur around 2055 based on the capture analysis. Based on 100 percent capture of stormwater, the Big Slough Basin may have an average annual flow of approximately 176 cfs without the Pine Level/Keys Tract, and approximately 164 cfs with the Pine Level/Keys Tract by 2055. Assuming a 50 percent capture of stormwater, the Big Slough Basin may have an average annual flow of approximately 170 cfs. This corresponds to a decrease in flow of 6 cfs. The Pine Level/Keys Tract accounts for a small relative contribution to the flows in Big Slough Basin. The Pine Level/Keys Tract effects on flow quantities in Big Slough Basin would likely be relatively small, most perceptible during high flow periods, and projected far into the future. The SWFWMD plans to revisit the flows in this watershed in more detail after more data are collected near the City of North Port.

5.6.3 Pine Level/Keys Tract Year 2034 Implementation Effects on Horse Creek

Table 56 presents the flow and percent change from 2009 average annual and seasonal flows during an average rainfall year with 100 percent capture of stormwater in the capture area of the Pine Level/Keys Tract in Horse Creek subwatershed. The maximum influence was predicted to occur around 2050 according to the capture analysis. Annual average flow increases by approximately 1 percent by 2050, dry season flow increases less than 1 percent, and wet season flow increases by approximately 3 percent from 2009 levels. Eventually the areas mined would be reclaimed and these potential flow reductions during active mining returned to near pre-mining conditions, but that would occur beyond 2060.

TABLE 56

Projected Flows and Percent Change from 2009 Flows during Average Rainfall Year and 100 Percent Capture in Horse Creek Flow Station with the Pine Level/Keys Tract

	Annual Average Flow (cfs)	Annual Average Percent Change from 2009 Flows	Dry Season Average Flow (cfs)	Dry Season Percent Change from 2009 Flows	Wet Season Average Flow (cfs)	Wet Season Percent Change from 2009 Flows
2009	171	0%	78	0%	404	0%
2020	173	1%	78	0%	413	2%
2030	173	1%	78	0%	416	3%
2040	174	2%	78	<1%	419	3%
2050	173	1%	78	0%	416	3%
2060	175	2%	79	1%	421	4%

Table 57 presents the flow and percent change from 2009 average annual and seasonal flows during an average rainfall year with 50 percent capture of stormwater in the capture area of the Pine Level/Keys Tract in Horse Creek subwatershed. The maximum influence was predicted to occur around 2050 based on the capture analysis. Annual average flow increases by approximately 2 percent by 2050, dry season flow increases by approximately 1 percent, and wet season flow increases by approximately 4 percent from 2009 levels.

TABLE 57

Projected Flows and Percent Change from 2009 Flows during Average Rainfall Year and 50 Percent Capture in Horse Creek Flow Station with the Pine Level/Keys Tract

	Annual Average Flow (cfs)	Annual Average Percent Change from 2009 Flows	Dry Season Average Flow (cfs)	Dry Season Percent Change from 2009 Flows	Wet Season Average Flow (cfs)	Wet Season Percent Change from 2009 Flows
2009	171	0%	78	0%	404	0%
2020	173	1%	78	0%	413	2%
2030	173	1%	78	0%	416	3%
2040	174	2%	78	1%	416	3%
2050	174	2%	78	<1%	419	4%
2060	176	3%	79	2%	423	5%

The same evaluation was performed for a low rainfall year. Table 58 presents the flow and percent change from 2009 average annual and seasonal flows during a low rainfall year with 100 percent capture of stormwater in the capture area of the Pine Level/Keys Tract. The maximum influence was predicted to occur around 2050 based on the capture analysis. Annual average flow increases by approximately 2 percent by 2050, dry season flow increases by approximately 1 percent, and wet season flow increases by approximately 3 percent from 2009 levels.

TABLE 58

Projected Flows and Percent Change from 2009 Flows during Low Rainfall Year and 100 Percent Capture Horse Creek Flow Station with the Pine Level/Keys Tract

	Annual Average Flow (cfs)	Annual Average Percent Change from 2009 Flows	Dry Season Average Flow (cfs)	Dry Season Percent Change from 2009 Flows	Wet Season Average Flow (cfs)	Wet Season Percent Change from 2009 Flows
2009	84	0%	38	0%	199	0%
2020	85	1%	38	0%	203	2%
2030	85	1%	38	0%	205	3%
2040	86	2%	38	1%	206	3%
2050	85	1%	38	0%	204	3%
2060	86	2%	39	1%	207	4%

Table 59 presents the flow and percent change from 2009 average annual and seasonal flows during a low rainfall year with 50 percent capture of stormwater in the capture area of the Pine Level/Keys Tract. The maximum influence was predicted to occur around 2050 based on the capture analysis. Annual average flow increases by approximately 2 percent by 2050, dry season flow increases by approximately 1 percent, and wet season flow increases by approximately 4 percent from 2009 levels.

TABLE 59

Projected Flows and Percent Change from 2009 Flows during Low Rainfall Year and 50 Percent Horse Creek Flow Station with the Pine Level/Keys Tract

	Annual Average Flow (cfs)	Annual Average Percent Change from 2009 Flows	Dry Season Average Flow (cfs)	Dry Season Percent Change from 2009 Flows	Wet Season Average Flow (cfs)	Wet Season Percent Change from 2009 Flows
2009	84	0%	38	0%	199	0%
2020	85	1%	38	0%	203	2%
2030	85	1%	38	0%	205	3%
2040	85	2%	38	1%	205	3%
2050	86	2%	38	1%	206	4%
2060	86	3%	39	2%	208	5%

To illustrate the effect on Horse Creek subwatershed stream flow under the conditions and scenarios evaluated, the results are presented graphically and compared to the No Action Alternative conditions. Figures 70 and 71 present the seasonal and annual average flows calculated for Horse Creek subwatershed with and without the Pine Level/Keys Tract based on 100 percent capture and 50 percent capture of stormwater, respectively, during average rainfall conditions.

FIGURE 70

Horse Creek Annual Average and Seasonal Projected Flows for Average Annual Rainfall based on 100 Percent Capture of Excess Rainfall with and without the Pine Level/Keys Tract

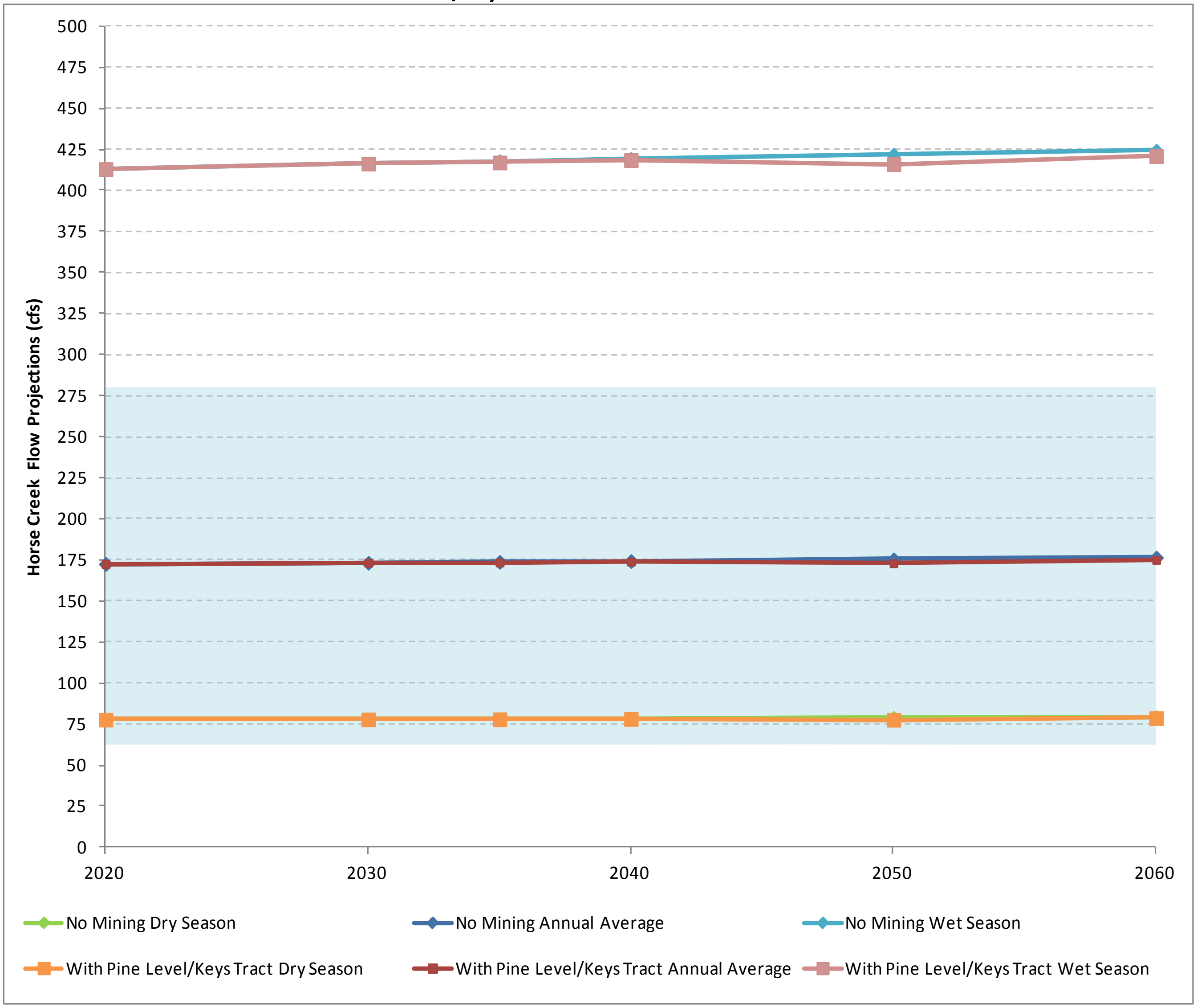
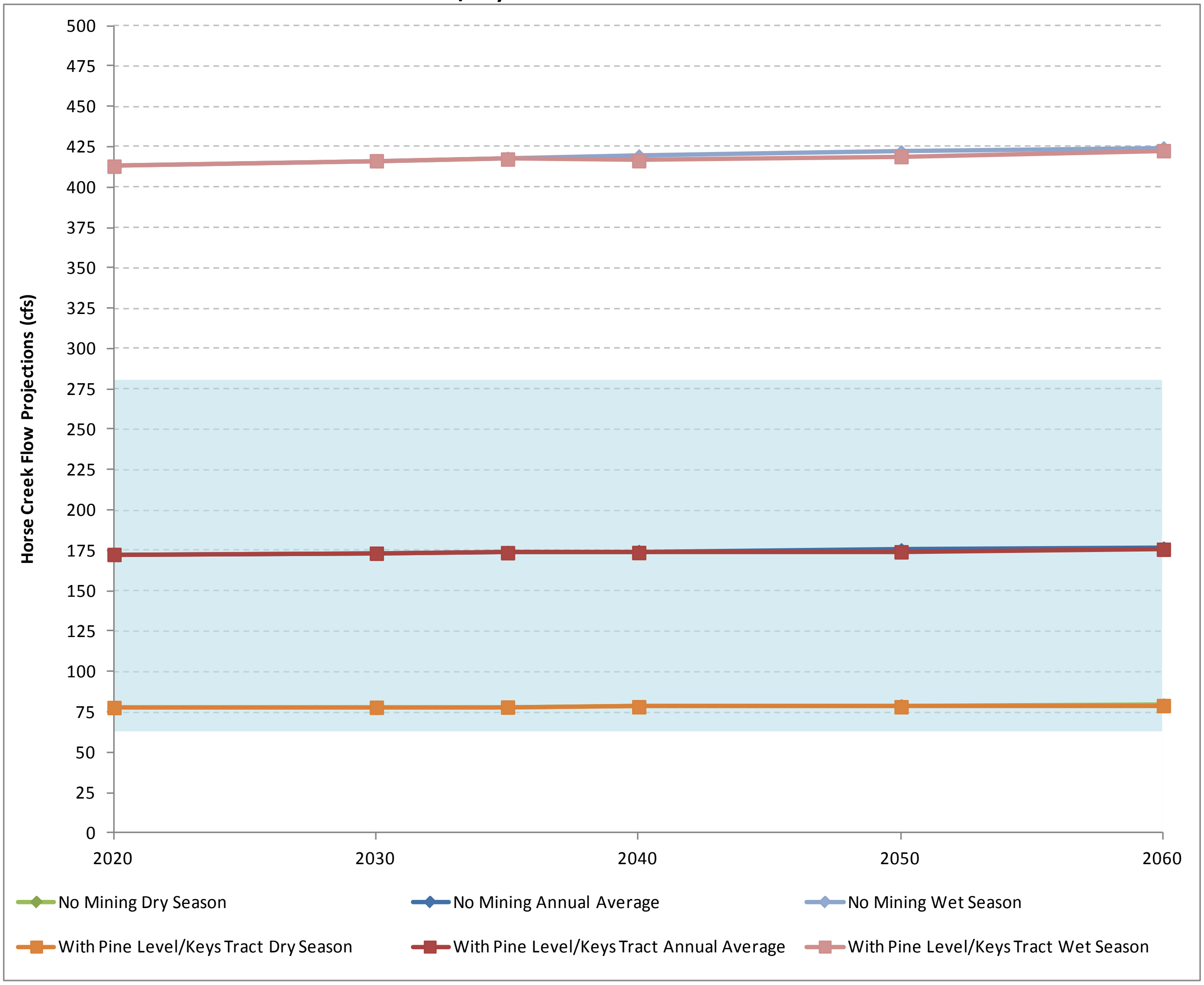


FIGURE 71
Horse Creek Annual Average and Seasonal Projected Flows for Average Annual Rainfall based on 50 Percent Capture of Excess Rainfall with and without the Pine Level/Keys Tract



The largest influence on annual average flow from the Horse Creek subwatershed during average rainfall conditions is predicted to occur 2050 based on the capture analysis. Based on 100 percent capture of stormwater, Horse Creek subwatershed may have an average annual flow of approximately 175 cfs without the Pine Level/Keys Tract and approximately 173 cfs with the Pine Level/Keys Tract during that period. Assuming a 50 percent capture of stormwater, Horse Creek subwatershed may have an average annual flow of approximately 174 cfs. This corresponds to a decrease in flow of 1 cfs when compared to the No Action Alternative conditions.

Figures 72 and 73 present the seasonal and annual average flows calculated for Horse Creek subwatershed with and without the Pine Level/Keys Tract based on 100 percent capture and 50 percent capture of stormwater, respectively, during low rainfall conditions.

FIGURE 72

Horse Creek Annual Average and Seasonal Projected Flows for Low Annual Rainfall based on 100 Percent Capture of Excess Rainfall with and without Pine Level/Keys Tract

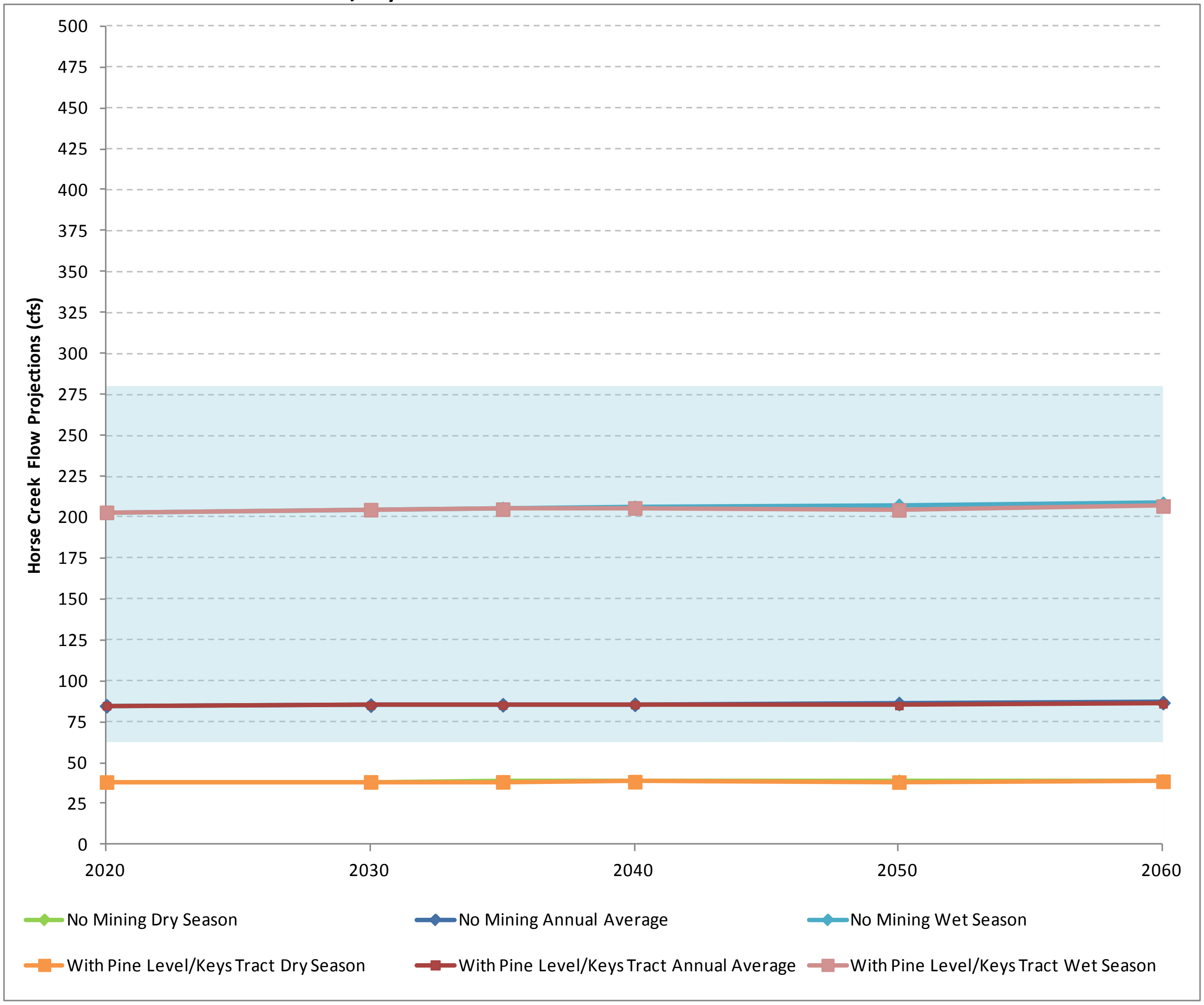
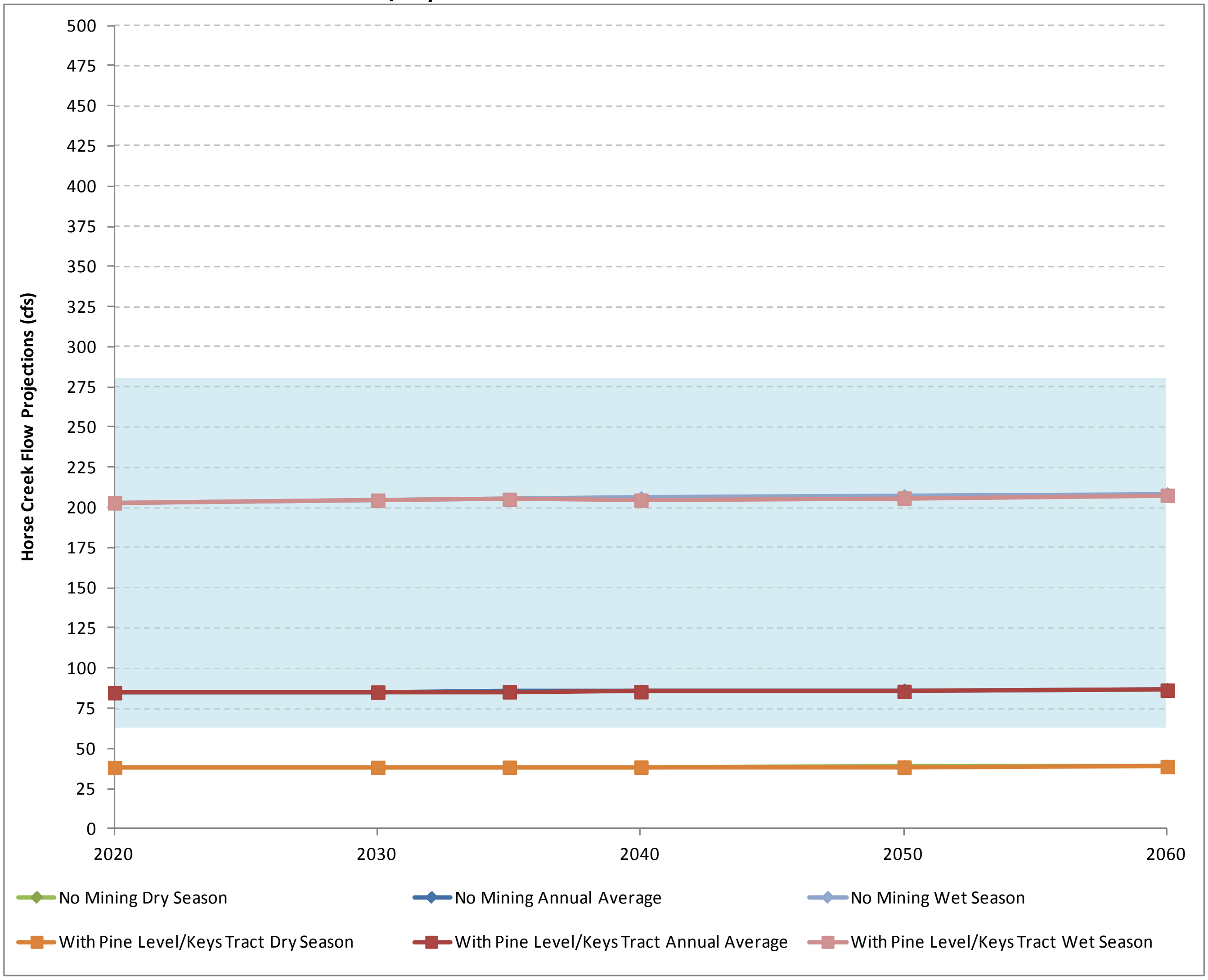


FIGURE 73
Horse Creek Annual Average and Seasonal Projected Flows for Low Annual Rainfall based on 50 Percent Capture of Excess Rainfall with and without the Pine Level/Keys Tract



Similar to average rainfall conditions, the largest influence on annual average flow from the Horse Creek subwatershed during low rainfall conditions was predicted to occur around 2040. Based on 100 percent capture of stormwater, the Horse Creek subwatershed may have an average annual flow of approximately 86 cfs without the Pine Level/Keys Tract, and approximately 85 cfs with the Pine Level/Keys Tract. Assuming a 50 percent capture of stormwater, the Horse Creek subwatershed may have an average annual flow of approximately 86 cfs. This corresponds to about the same flow when compared to No Action Alternative conditions.

5.7 Pioneer Offsite Alternative Impacts on Runoff Characteristics and Stream Flow

Pioneer Tract was also considered both as a stand-alone offsite alternative and as a reasonably foreseeable future action (as an extension to the Ona Mine), so two analyses were conducted. Again, the stand-alone alternative was assumed to start in 2025 even though its feasibility is unknown, and there will be some start-up issues to deal with like a new beneficiation plant and CSA, similar to any other new alternative that is not an extension or adjacent to another active mine. The future action is assumed to start in 2048. Each separate analysis, stand-alone and extension, are presented below.

5.7.1 Pioneer Tract Alternative Year 2025 Implementation

As with the previous alternatives where the footprint lies in different subwatersheds, the analysis provides the results by subwatershed. The impacts of this alternative on surface water runoff potential were calculated by evaluating the change to the runoff coefficients in the Horse Creek and the Peace River at Arcadia subwatersheds.

5.7.1.1 Pioneer Tract Year 2025 Implementation Effects on Horse Creek

Table 60 presents the flow and percent change from 2009 average annual and seasonal flows during an average rainfall year with 100 percent capture of stormwater in the capture area of the Pioneer Tract at the Horse Creek flow station (near Arcadia). The maximum influence (i.e., largest capture area) was predicted to occur around 2050. Flows in Horse Creek are predicted to increase based on land use changes alone. Annual average flow decreases by approximately 3 percent by 2050, dry season flow decreases by approximately 4 percent, and wet season flow decreases by approximately 1 percent when compared to 2009 flows. Flow is expected to return to near No Action Alternative conditions by 2060 and is slightly higher than 2009 flow because of changes to land use.

TABLE 60

Projected Flows and Percent Change from 2009 Flows during Average Rainfall Year and 100 Percent Capture at the Horse Creek Flow Station with the Pioneer Tract

	Annual Average Flow (cfs)	Annual Average Percent Change from 2009 Flows	Dry Season Average Flow (cfs)	Dry Season Average Percent Change from 2009 Flows	Wet Season Average Flow (cfs)	Wet Season Average Percent Change from 2009 Flows
2009	171	0%	78	0%	404	0%
2020	173	1%	78	0%	413	2%
2030	170	-1%	76	-2%	408	1%
2040	169	-1%	76	-2%	407	1%
2050	165	-3%	75	-4%	400	-1%
2060	174	2%	78	1%	418	3%

Table 61 presents the flow and percent change from 2009 average annual and seasonal flows during an average rainfall year with 50 percent capture of stormwater in the capture area of the Pioneer Tract at the Horse Creek flow station. By 2050 the annual average flow with the Pioneer Tract remains about the same as the 2009 flow after accounting for increases from land use, dry season flow decreases by approximately 1 percent, and wet season flow increases by 2 percent from 2009 levels.

TABLE 61

Projected Flows and Percent Change from 2009 Flows during Average Rainfall Year and 50 Percent Capture at the Horse Creek Flow Station with the Pioneer Tract

	Annual Average Flow (cfs)	Annual Average Percent Change from 2009 Flows	Dry Season Average Flow (cfs)	Dry Season Average Percent Change from 2009 Flows	Wet Season Average Flow (cfs)	Wet Season Average Percent Change from 2009 Flows
2009	171	0%	78	0%	404	0%
2020	173	1%	78	0%	413	2%
2030	172	<1%	77	-1%	412	2%
2040	172	1%	77	-1%	413	2%
2050	171	0%	77	-1%	411	2%
2060	175	2%	79	1%	421	4%

The same evaluation was performed for a low rainfall year. Table 62 presents the flow and percent change from 2009 average annual and seasonal flows during a low rainfall year with 100 percent capture of stormwater in the capture area of the Pioneer Tract at the Horse Creek flow station. Similar to the average rainfall conditions evaluation, annual average flow does not change by much. The average annual flow decreases by approximately 3 percent by 2050, dry season flows decrease by 4 percent, and wet season flow decreases by approximately 1 percent from when compared to 2009 flows. The flows recover after 2050 to a level that is slightly higher than the 2009 levels resulting from land use change. All differences in this case are only a few cfs.

TABLE 62

Projected Flows and Percent Change from 2009 Flows during Low Rainfall Year and 100 Percent Capture at the Horse Creek Flow Station with the Pioneer Tract

	Annual Average Flow (cfs)	Annual Average Percent Change from 2009 Flows	Dry Season Average Flow (cfs)	Dry Season Average Percent Change from 2009 Flows	Wet Season Average Flow (cfs)	Wet Season Average Percent Change from 2009 Flows
2009	84	0%	38	0%	199	0%
2020	85	1%	38	0%	203	2%
2030	83	-1%	38	-2%	201	1%
2040	83	-1%	37	-2%	200	1%
2050	82	-3%	37	-4%	197	-1%
2060	85	2%	38	1%	205	3%

Table 63 presents the flow and percent change from 2009 average annual and seasonal flows during a low rainfall year with 50 percent capture of stormwater in the capture area of the Pioneer Tract at the Horse Creek flow station. By 2050 the annual average flow remains about the same, dry season flow decreases by approximately 1 percent or less, and wet season flow increases by approximately 1 percent from 2009 flows.

TABLE 63

Projected Flows and Percent Change from 2009 Flows during Low Rainfall Year and 50 Percent Capture at the Horse Creek Flow Station with the Pioneer Tract

	Annual Average Flow (cfs)	Annual Average Percent Change from 2009 Flows	Dry Season Average Flow (cfs)	Dry Season Average Percent Change from 2009 Flows	Wet Season Average Flow (cfs)	Wet Season Average Percent Change from 2009 Flows
2009	84	0%	38	0%	199	0%
2020	85	1%	38	0%	203	2%
2030	84	0%	38	<-1%	203	2%
2040	84	<1%	38	<-1%	203	2%
2050	84	0%	38	<-1%	202	2%
2060	86	2%	39	1%	207	4%

To illustrate the effect on Horse Creek stream flow under the conditions and scenarios evaluated, the results are presented graphically and compared to the No Action Alternative conditions. Figures 74 and 75 present the seasonal and annual average flows calculated for the Horse Creek gage station with and without the Pioneer Tract based on 100 percent capture and 50 percent capture of stormwater, respectively, during average rainfall conditions.

FIGURE 74

Horse Creek Annual Average and Seasonal Projected Flows for Average Annual Rainfall based on 100 Percent Capture of Excess Rainfall with and without the Pioneer Tract

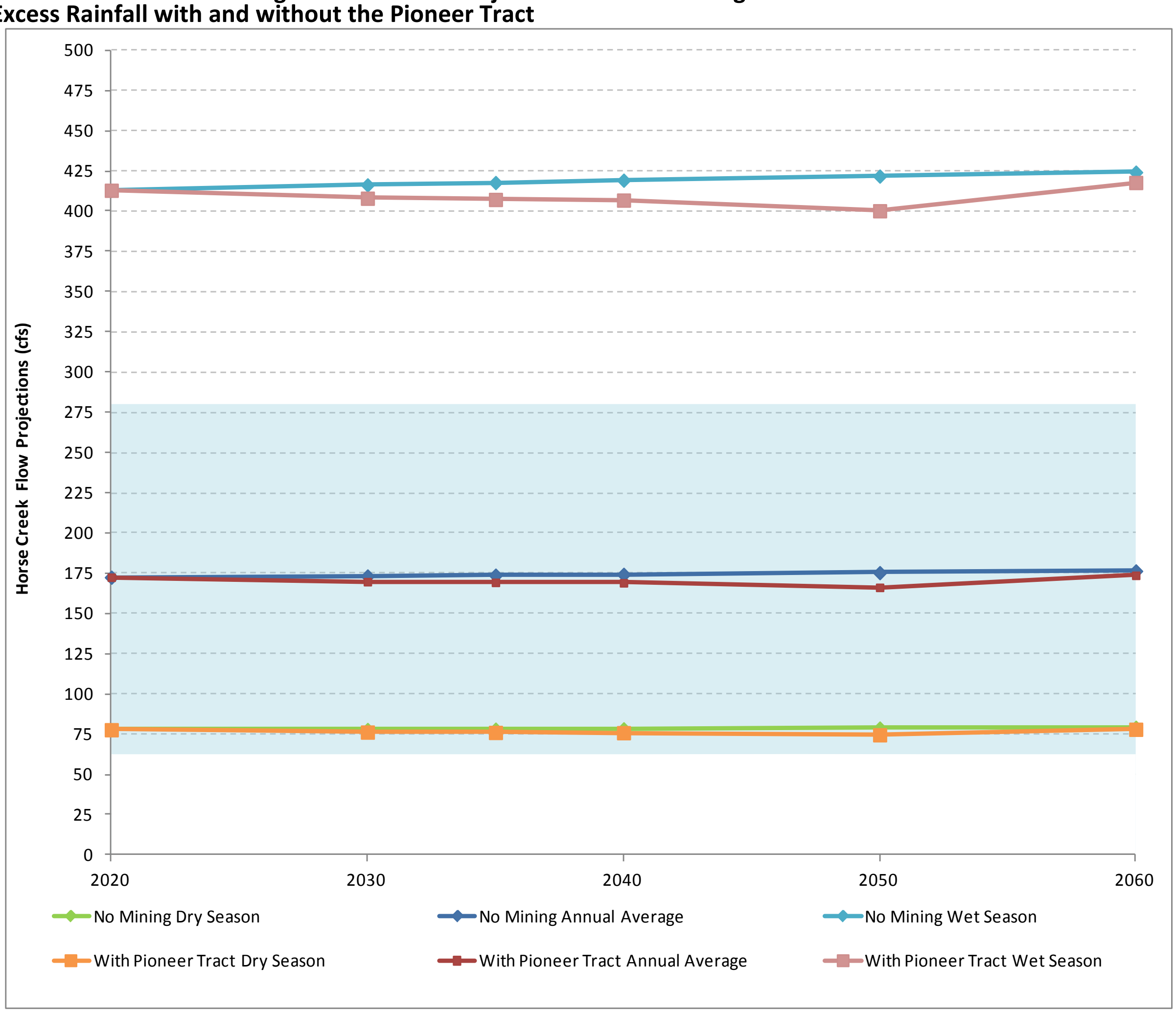
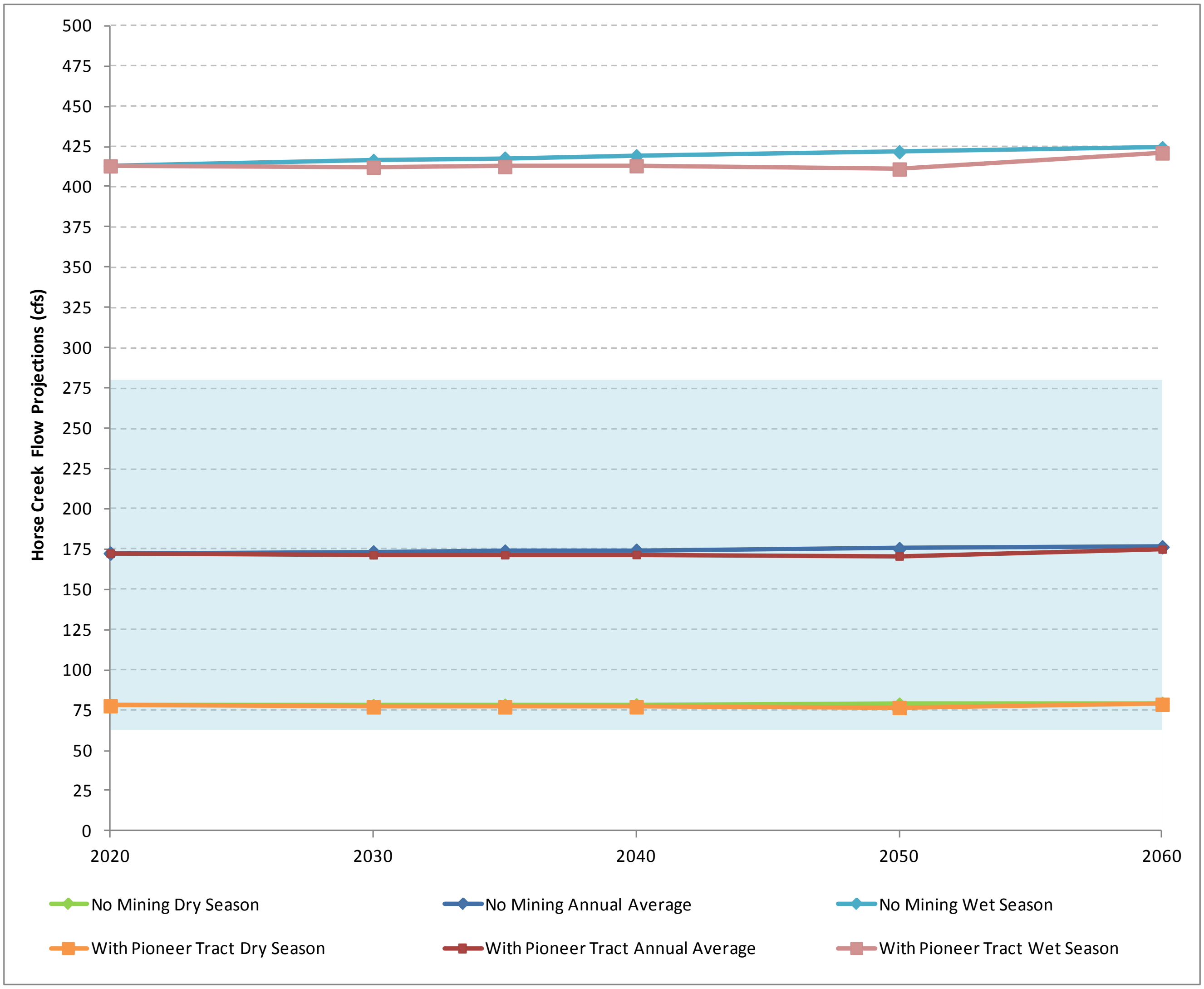


FIGURE 75

Horse Creek Annual Average and Seasonal Projected Flows for Average Annual Rainfall based on 50 Percent Capture of Excess Rainfall with and without the Pioneer Tract



Based on 100 percent capture of stormwater, Horse Creek may have an average annual flow of approximately 175 cfs without the Pioneer Tract and approximately 166 cfs with the Pioneer Tract by 2050. Assuming a 50 percent capture of stormwater, Horse Creek may have an average annual flow of approximately 171 cfs by 2050. This corresponds to a decrease in flow of about 4 cfs when compared to the No Action Alternative conditions.

Figures 76 and 77 present the seasonal and annual average flows calculated for the Horse Creek gage station with and without the Pioneer Tract based on 100 percent capture and 50 percent capture of stormwater, respectively, during low rainfall conditions.

FIGURE 76

Horse Creek Annual Average and Seasonal Projected Flows for Low Annual Rainfall based on 100 Percent Capture of Excess Rainfall with and without the Pioneer Tract

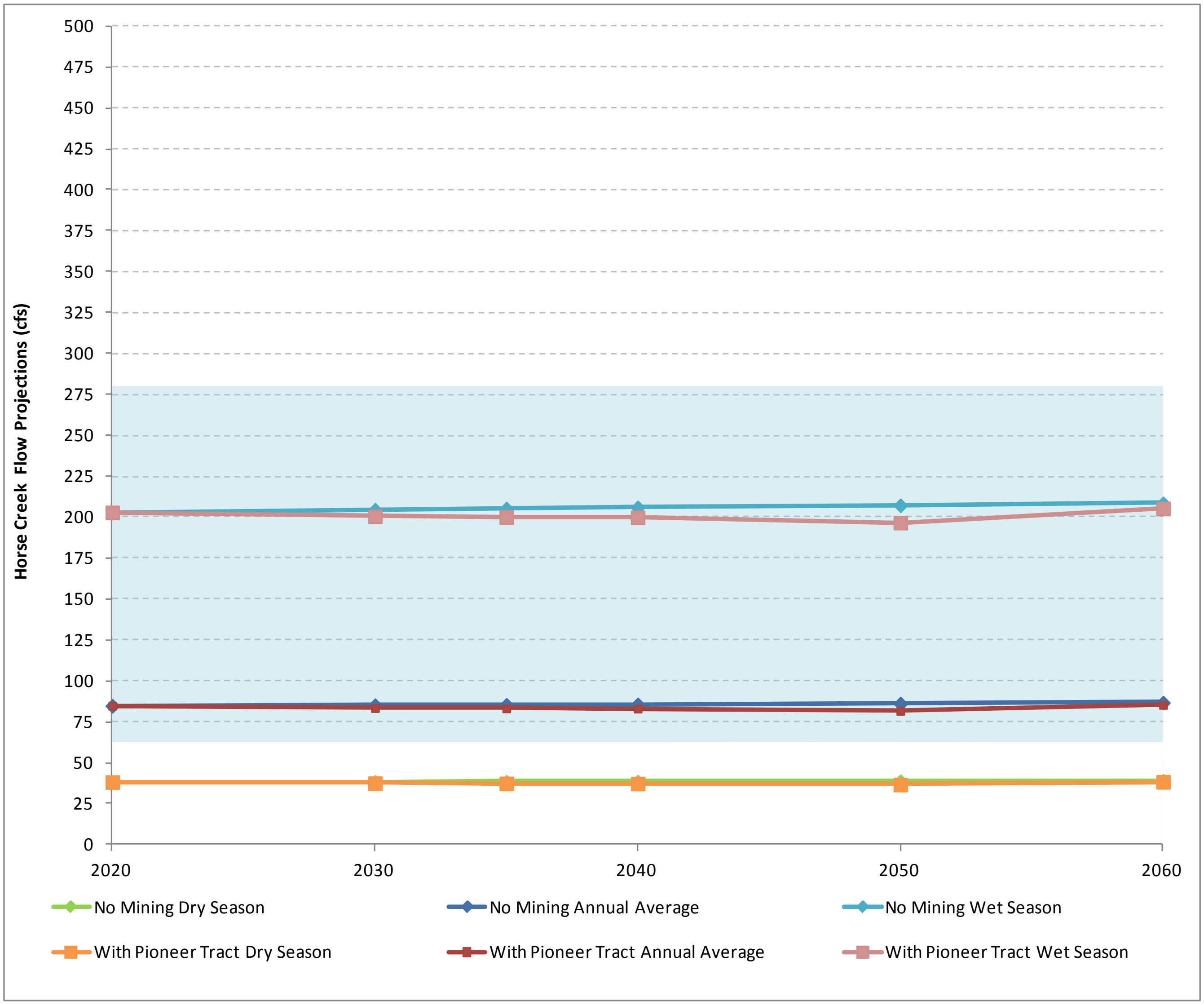
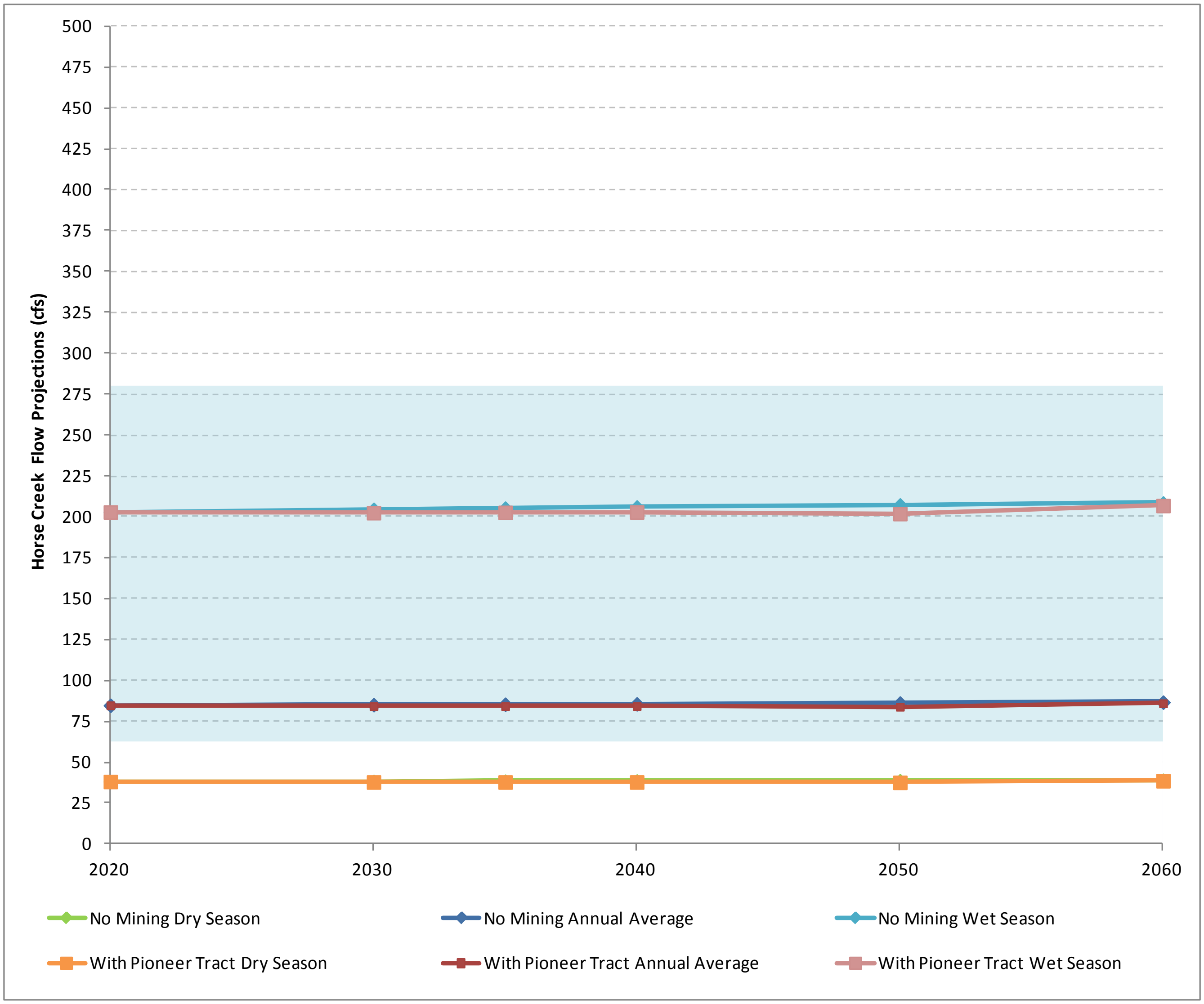


FIGURE 77
Horse Creek Annual Average and Seasonal Projected Flows for Low Annual Rainfall based on 50 Percent Capture of Excess Rainfall with and without Pioneer Tract



Based on 100 percent capture of stormwater, Horse Creek may have an average annual flow of approximately 86 cfs by 2050 without the Pioneer Tract and approximately 82 cfs with the Pioneer Tract. Assuming a 50 percent capture of stormwater, Horse Creek may have an average annual flow of approximately 84 cfs by 2050. This corresponds to a decrease in flow of 2 cfs when compared to the No Action Alternative conditions.

5.7.1.2 Pioneer Tract Year 2025 Implementation Effects on Peace River at Arcadia

Table 64 presents the flow and percent change from 2009 average annual and seasonal flows during an average rainfall year with 100 percent capture of stormwater in the capture area of the Pioneer Tract at the Peace River at Arcadia station. The maximum impact in the Peace River at Arcadia subwatershed occurs around 2040 according to the capture curve, sooner than in Horse Creek subwatershed. Based on projected land use changes within the subwatershed and upstream subwatersheds, flows are predicted to increase during the Pioneer Tract mining period through 2060. By 2040 the annual average flow increases by approximately 5 percent, dry season flow increases by approximately 4 percent, and wet season flow increases by approximately 7 percent from 2009 levels. Considering the small percentage of land that would be mined compared to the total drainage area of this gage station, the changes in projected land use are predicted to have more of an effect on flow than the Pioneer Tract stormwater capture.

TABLE 64

Projected Flows and Percent Change from 2009 Flows during Average Rainfall Year and 100 Percent Capture at the Peace River at Arcadia Flow Station with the Pioneer Tract

	Annual Average Flow (cfs)	Annual Average Percent Change from 2009 Flows	Dry Season Average Flow (cfs)	Dry Season Average Percent Change from 2009 Flows	Wet Season Average Flow (cfs)	Wet Season Average Percent Change from 2009 Flows
2009	713	0%	328	0%	1,657	0%
2020	726	2%	332	1%	1,702	3%
2030	734	3%	334	2%	1,734	5%
2040	749	5%	340	4%	1,773	7%
2050	768	8%	348	6%	1818	10%
2060	782	10%	355	8%	1,856	12%

Table 65 presents the flow and percent change from 2009 average annual and seasonal flows during an average rainfall year with 50 percent capture of stormwater in the capture area of the Pioneer Tract at the Peace River at Arcadia gage station. Similar to the 100 percent capture case, based on land use changes within the subwatershed and upstream subwatersheds, flows are predicted to increase during the Pioneer Tract mining period in excess of any impact. Annual average flow increases by approximately 5 percent by 2040, dry season flow increases by approximately 4 percent, and wet season flow increases by approximately 7 percent from 2009 levels.

TABLE 65

Projected Flows and Percent Change from 2009 Flows during Average Rainfall Year and 50 Percent Capture at the Peace River at Arcadia Flow Station with the Pioneer Tract

	Annual Average Flow (cfs)	Annual Average Percent Change from 2009 Flows	Dry Season Average Flow (cfs)	Dry Season Average Percent Change from 2009 Flows	Wet Season Average Flow (cfs)	Wet Season Average Percent Change from 2009 Flows
2009	713	0%	328	0%	1,657	0%
2020	726	2%	332	1%	1,702	3%
2030	736	3%	335	2%	1,738	5%
2040	752	5%	341	4%	1,779	7%
2050	770	8%	349	7%	1,824	10%
2060	783	10%	355	8%	1,857	12%

The same evaluation was performed for a low rainfall year. Table 66 presents the flow and percent change from 2009 average annual and seasonal flows during a low rainfall year with 100 percent capture of stormwater in the capture area of the Pioneer Tract. Flows are predicted to increase from 2009 levels by approximately 10 percent by 2060. Annual average flow increases by approximately 5 percent by 2040, dry season flow increases by approximately 4 percent, and wet season flow increases by approximately 7 percent from 2009 levels.

TABLE 66

Projected Flows and Percent Change from 2009 Flows during Low Rainfall Year and 100 Percent Capture at the Peace River at Arcadia Flow Station with the Pioneer Tract

	Annual Average Flow (cfs)	Annual Average Percent Change from 2009 Flows	Dry Season Average Flow (cfs)	Dry Season Average Percent Change from 2009 Flows	Wet Season Average Flow (cfs)	Wet Season Average Percent Change from 2009 Flows
2009	330	0%	152	0%	766	0%
2020	337	2%	154	1%	787	3%
2030	340	3%	155	2%	803	5%
2040	347	5%	158	4%	822	7%
2050	356	8%	162	7%	844	10%
2060	363	10%	165	8%	861	12%

Table 67 presents the flow and percent change from 2009 average annual and seasonal flows during a low rainfall year with 50 percent capture of stormwater in the capture area of the Pioneer Tract. Similar to the average rainfall year scenario, based on projected land use changes within the subwatershed and upstream subwatersheds, flows are predicted to increase during the Pioneer Tract mining period through 2060. Annual average flow increases by approximately 6 percent by 2040, dry season flow increases by approximately 4 percent, and wet season flow increases by approximately 8 percent from 2009 levels.

TABLE 67

Projected Flows and Percent Change from 2009 Flows during Low Rainfall Year and 50 Percent Capture at the Peace River at Arcadia Flow Station with the Pioneer Tract

	Annual Average Flow (cfs)	Annual Average Percent Change from 2009 Flows	Dry Season Average Flow (cfs)	Dry Season Average Percent Change from 2009 Flows	Wet Season Average Flow (cfs)	Wet Season Average Percent Change from 2009 Flows
2009	330	0%	152	0%	766	0%
2020	337	2%	154	1%	787	3%
2030	341	3%	155	2%	805	5%
2040	349	6%	158	4%	825	8%
2050	357	8%	162	7%	846	10%
2060	363	10%	165	9%	861	12%

To illustrate the effect on Peace River at Arcadia stream flow under the conditions and scenarios evaluated, the results are presented graphically and compared to the No Action Alternative conditions. Figures 78 and 79 present the seasonal and annual average flows calculated for the Peace River at Arcadia gage station with and without the Pioneer Tract based on 100 percent capture and 50 percent capture of stormwater, respectively, during average rainfall conditions.

FIGURE 78

Peace River at Arcadia Annual Average and Seasonal Projected Flows for Average Annual Rainfall based on 100 Percent Capture of Excess Rainfall with and without the Pioneer Tract

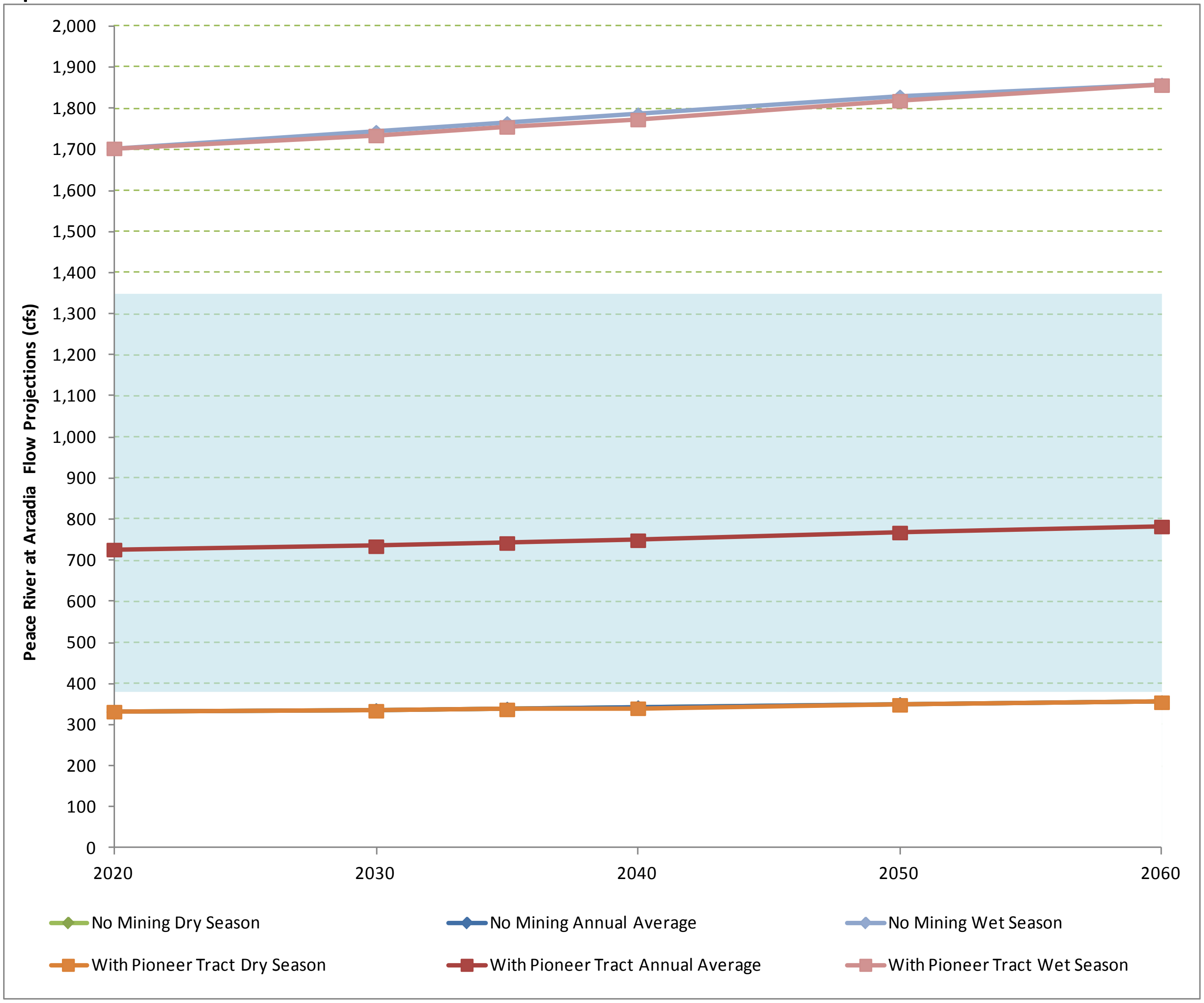
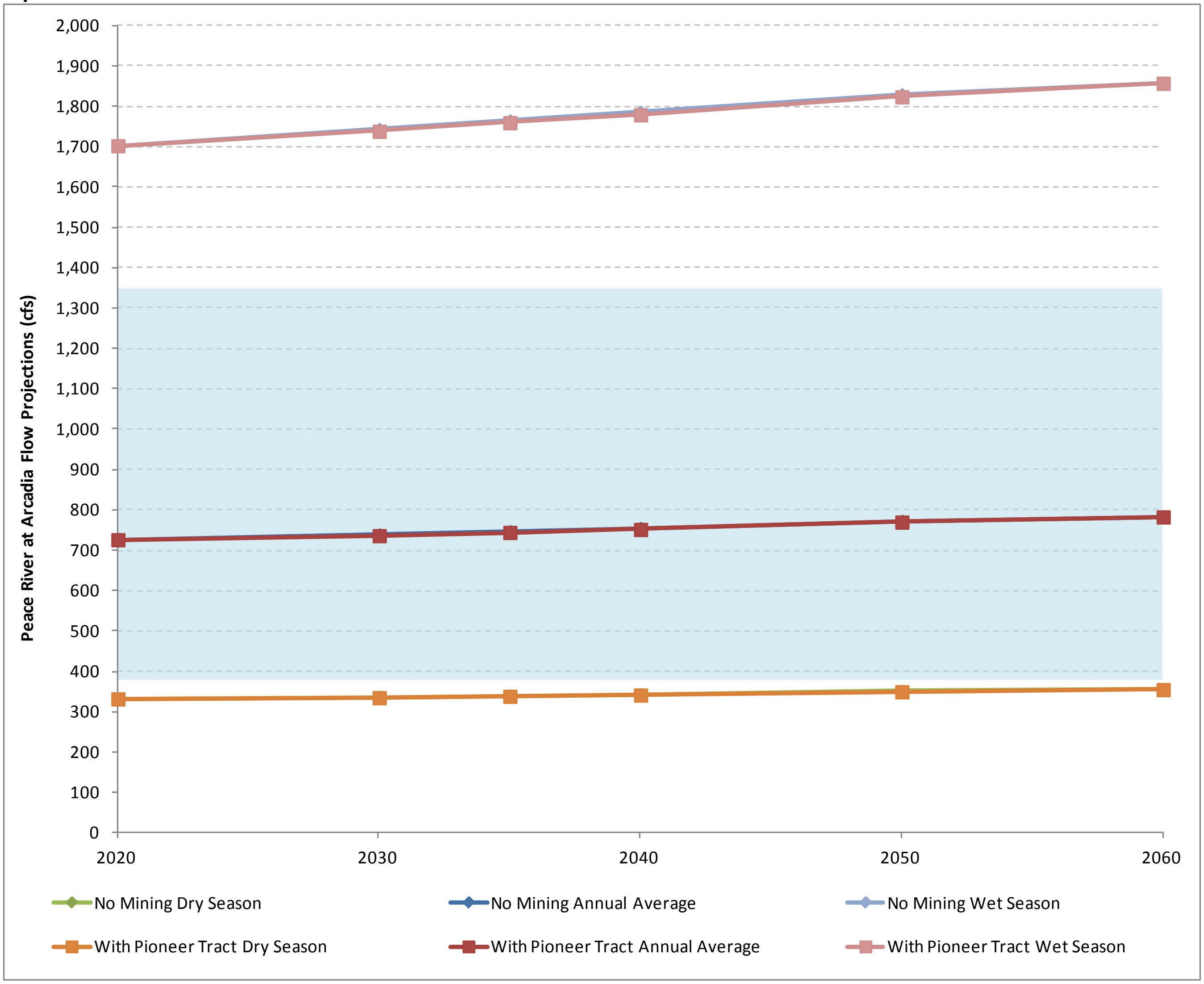


FIGURE 79

Peace River at Arcadia Annual Average and Seasonal Projected Flows for Average Annual Rainfall based on 50 Percent Capture of Excess Rainfall with and without the Pioneer Tract



The largest influences on annual average flow from the Peace River at Arcadia subwatershed during average rainfall conditions were predicted around 2040 based on the capture analysis. Based on 100 percent capture of stormwater, Peace River at Arcadia may have an average annual flow of approximately 754 cfs by 2040 without the Pioneer Tract and approximately 749 cfs with the Pioneer Tract. Reductions in flow resulting from mine capture are expected to be less than the anticipated flow increases associated with projected changes in land use. Assuming a 50 percent capture of stormwater, Peace River at Arcadia may have an average annual flow of approximately 752 cfs. This corresponds to a decrease in flow of 2 cfs when compared to the No Action Alternative conditions, which is negligible.

Figures 80 and 81 present the seasonal and annual average flows calculated for the Peace River at Arcadia gage station with and without the Pioneer Tract based on 100 percent capture and 50 percent capture of stormwater, respectively, during low rainfall conditions.

FIGURE 80

Peace River at Arcadia Annual Average and Seasonal Projected Flows for Low Annual Rainfall based on 100 Percent Capture of Excess Rainfall with and without the Pioneer Tract

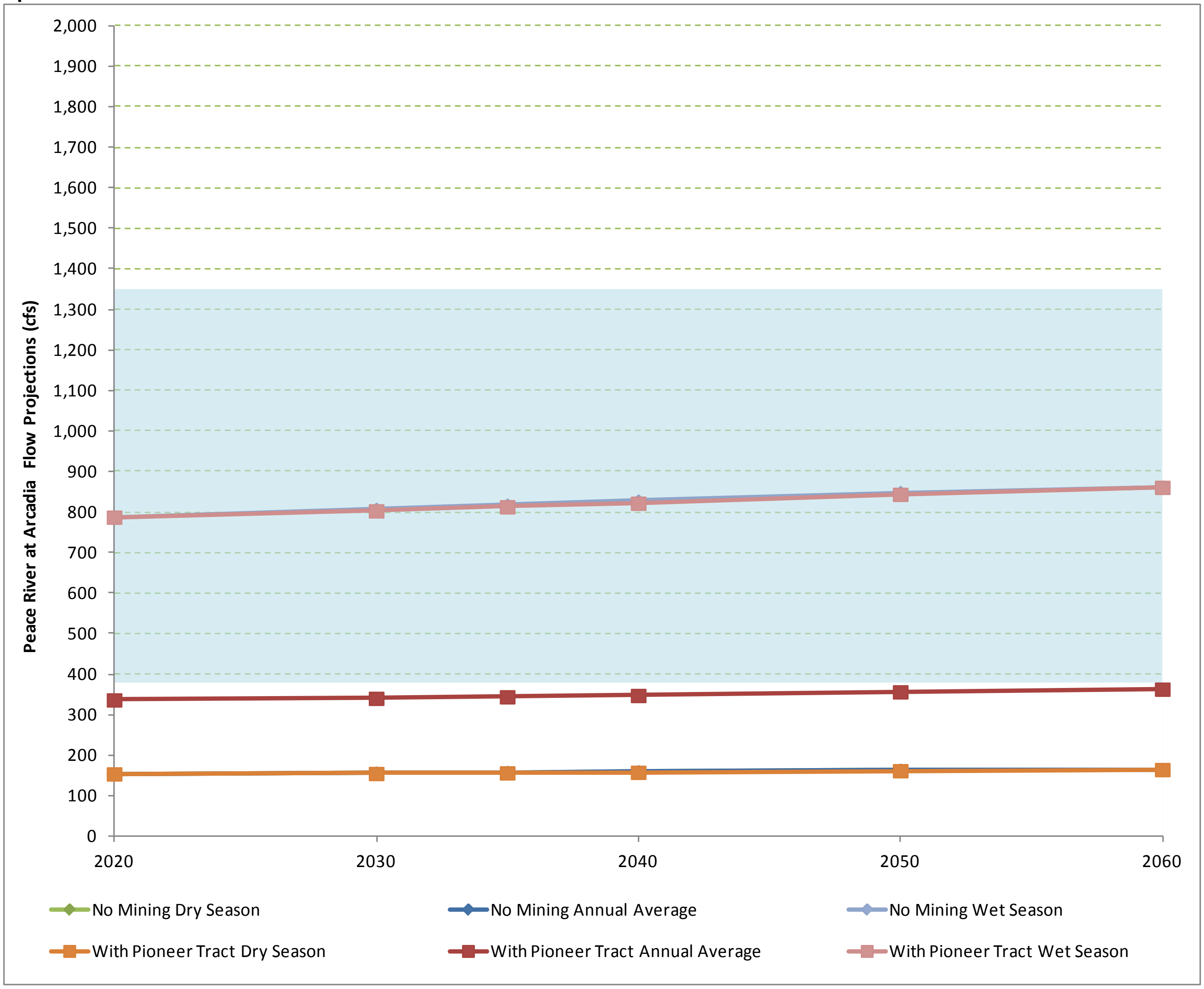
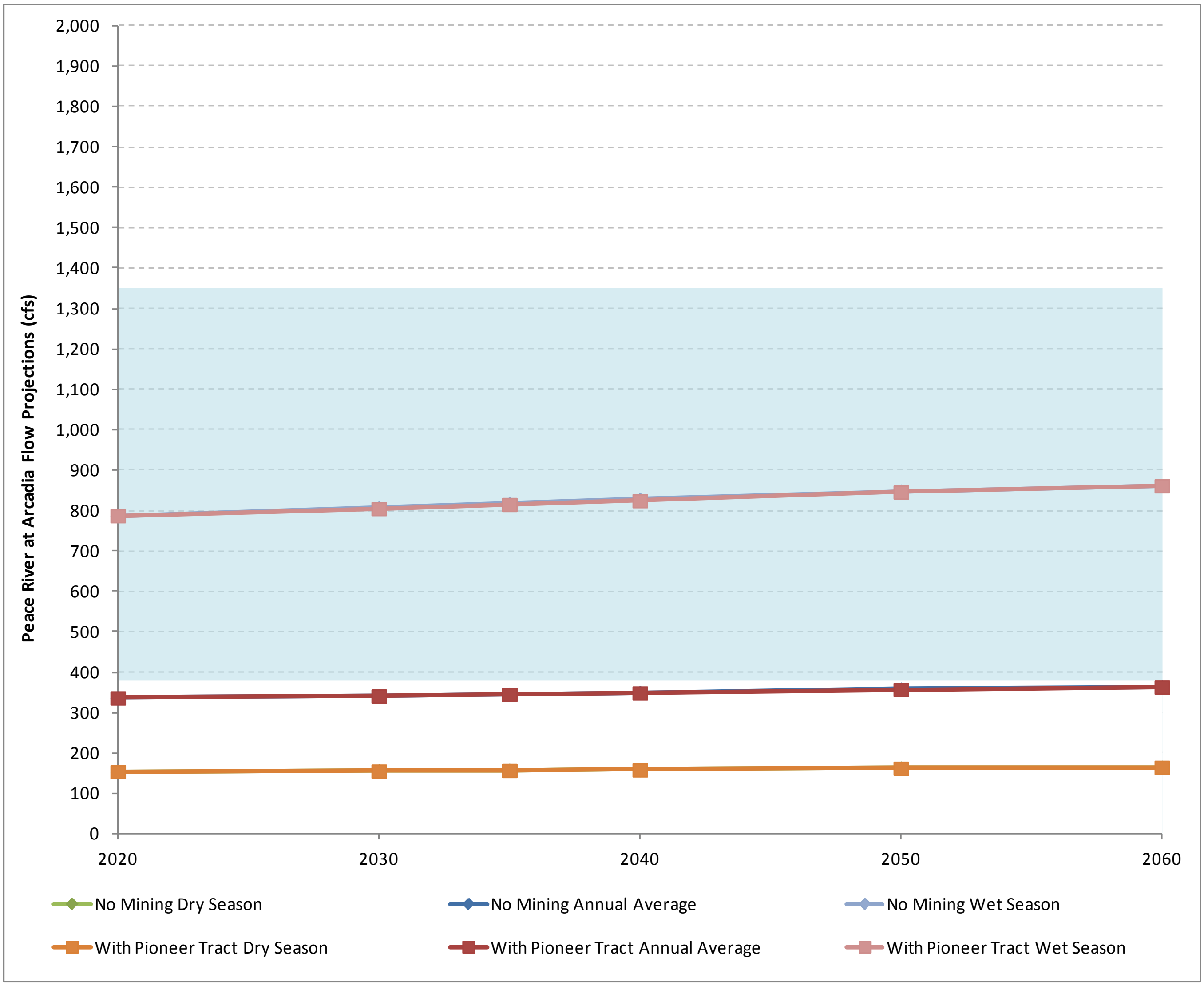


FIGURE 81

Peace River at Arcadia Annual Average and Seasonal Projected Flows for Low Annual Rainfall based on 50 Percent Capture of Excess Rainfall with and without Pioneer Tract



Results of the low rainfall year were similar to average rainfall conditions. Based on 100 percent capture of stormwater, Peace River at Arcadia may have an average annual flow of approximately 350 cfs by 2040 without the Pioneer Tract and approximately 347 cfs with the Pioneer Tract. Assuming a 50 percent capture of stormwater, Peace River at Arcadia may have an average annual flow of approximately 349 cfs, nearly identical to the No Action Alternative conditions.

The Pioneer Tract has a small relative contribution to the flows measured at the Peace River at Arcadia gage station because of its relative size. The Pioneer Tract impact on flow quantities at this station would likely not be perceivable, particularly since flows are expected to increase as a result of projected land use changes in the Peace River at Arcadia drainage area.

5.7.2 Pioneer Tract Alternative Year 2048 Implementation

As a reasonably foreseeable future action, Pioneer Tract would be an extension to the Ona Mine. It is estimated that mining at this alternative would not begin until 2048. While evaluated separately, the impacts are expected to be a continuation of the Ona Mine in time.

5.7.2.1 Pioneer Tract Year 2048 Implementation Effects on Horse Creek

Table 68 presents the flow and percent change from 2009 average annual and seasonal flows during an average rainfall year with 100 percent capture of stormwater in the capture area of the Pioneer Tract at the Horse Creek flow station (near Arcadia). The maximum influence (i.e., largest capture area) was predicted to occur around 2070, further in the future than the extent of this analysis. Therefore, the expected conditions for 2060 are discussed for this evaluation. Flows in Horse Creek are predicted to increase based on land use changes alone. The flow decreases projected to occur resulting from Pioneer Tract impacts are projected to be less than the increase in flow resulting from projected land use changes since 2009. Annual average flow increases by approximately 1 percent, dry season flow decreases by approximately less than 1 percent, and wet season flow increases by approximately 2 percent when compared to 2009 flows.

TABLE 68

Projected Flows and Percent Change from 2009 Flows during Average Rainfall Year and 100 Percent Capture at the Horse Creek Flow Station with the Pioneer Tract

	Annual Average Flow (cfs)	Annual Average Percent Change from 2009 Flows	Dry Season Average Flow (cfs)	Dry Season Average Percent Change from 2009 Flows	Wet Season Average Flow (cfs)	Wet Season Average Percent Change from 2009 Flows
2009	171	0%	78	0%	404	0%
2020	173	1%	78	0%	413	2%
2030	173	1%	78	0%	416	3%
2040	174	2%	78	1%	419	4%
2050	174	2%	78	1%	418	3%
2060	172	1%	77	0%	414	2%

Table 69 presents the flow and percent change from 2009 average annual and seasonal flows during an average rainfall year with 50 percent capture of stormwater in the capture area of the Pioneer Tract at the Horse Creek flow station. Similar to the 100 percent capture analysis, annual average flow increases by approximately 2 percent, dry season flow increases by approximately 1 percent, and wet season flow increases by 4 percent from 2009 levels. When considering only the Pioneer Tract, changes in land use within this watershed result in the annual average flow increasing when compared to 2009 flow even when the capture area associated with the Pioneer Tract is included.

TABLE 69

Projected Flows and Percent Change from 2009 Flows during Average Rainfall Year and 50 Percent Capture at the Horse Creek Flow Station with the Pioneer Tract

	Annual Average Flow (cfs)	Annual Average Percent Change from 2009 Flows	Dry Season Average Flow (cfs)	Dry Season Average Percent Change from 2009 Flows	Wet Season Average Flow (cfs)	Wet Season Average Percent Change from 2009 Flows
2009	171	0%	78	0%	404	0%
2020	173	1%	78	0%	413	2%
2030	173	1%	78	0%	416	3%
2040	174	2%	78	<1%	419	4%
2050	175	2%	78	<1%	420	4%
2060	174	2%	78	<1%	419	4%

The same evaluation was performed for a low rainfall year. Table 70 presents the flow and percent change from 2009 average annual and seasonal flows during a low rainfall year with 100 percent capture of stormwater in the capture area of the Pioneer Tract at the Horse Creek flow station. Similar to the average rainfall conditions evaluation, annual average flow increases by approximately 1 percent, dry season flows remain approximately the same, and wet season flow increases by approximately 2 percent from when compared to 2009 flows.

TABLE 70

Projected Flows and Percent Change from 2009 Flows during Low Rainfall Year and 100 Percent Capture at the Horse Creek Flow Station with the Pioneer Tract

	Annual Average Flow (cfs)	Annual Average Percent Change from 2009 Flows	Dry Season Average Flow (cfs)	Dry Season Average Percent Change from 2009 Flows	Wet Season Average Flow (cfs)	Wet Season Average Percent Change from 2009 Flows
2009	84	0%	38	0%	199	0%
2020	85	1%	38	0%	203	2%
2030	85	1%	38	0%	205	3%
2040	86	2%	39	1%	206	4%
2050	85	2%	38	<11%	205	3%
2060	85	1%	38	0%	203	2%

Table 71 presents the flow and percent change from 2009 average annual and seasonal flows during a low rainfall year with 50 percent capture of stormwater in the capture area of the Pioneer Tract at the Horse Creek flow station. Annual average flow increases by approximately 2 percent, dry season flow increases by approximately 1 percent, and wet season flow increases by approximately 4 percent from 2009 flows.

TABLE 71

Projected Flows and Percent Change from 2009 Flows during Low Rainfall Year and 50 Percent Capture at the Horse Creek Flow Station with the Pioneer Tract

	Annual Average Flow (cfs)	Annual Average Percent Change from 2009 Flows	Dry Season Average Flow (cfs)	Dry Season Average Percent Change from 2009 Flows	Wet Season Average Flow (cfs)	Wet Season Average Percent Change from 2009 Flows
2009	84	0%	38	0%	199	0%
2020	85	1%	38	0%	203	2%
2030	85	1%	38	0%	205	3%
2040	86	2%	39	1%	206	4%
2050	86	2%	39	1%	206	4%
2060	86	2%	38	<1%	206	4%

To illustrate the effect on Horse Creek stream flow under the conditions and scenarios evaluated, the results are presented graphically and compared to the No Action Alternative conditions. Figures 82 and 83 present the seasonal and annual average flows calculated for the Horse Creek gage station with and without the Pioneer Tract based on 100 percent capture and 50 percent capture of stormwater, respectively, during average rainfall conditions.

FIGURE 82

Horse Creek Annual Average and Seasonal Projected Flows for Average Annual Rainfall based on 100 Percent Capture of Excess Rainfall with and without the Pioneer Tract

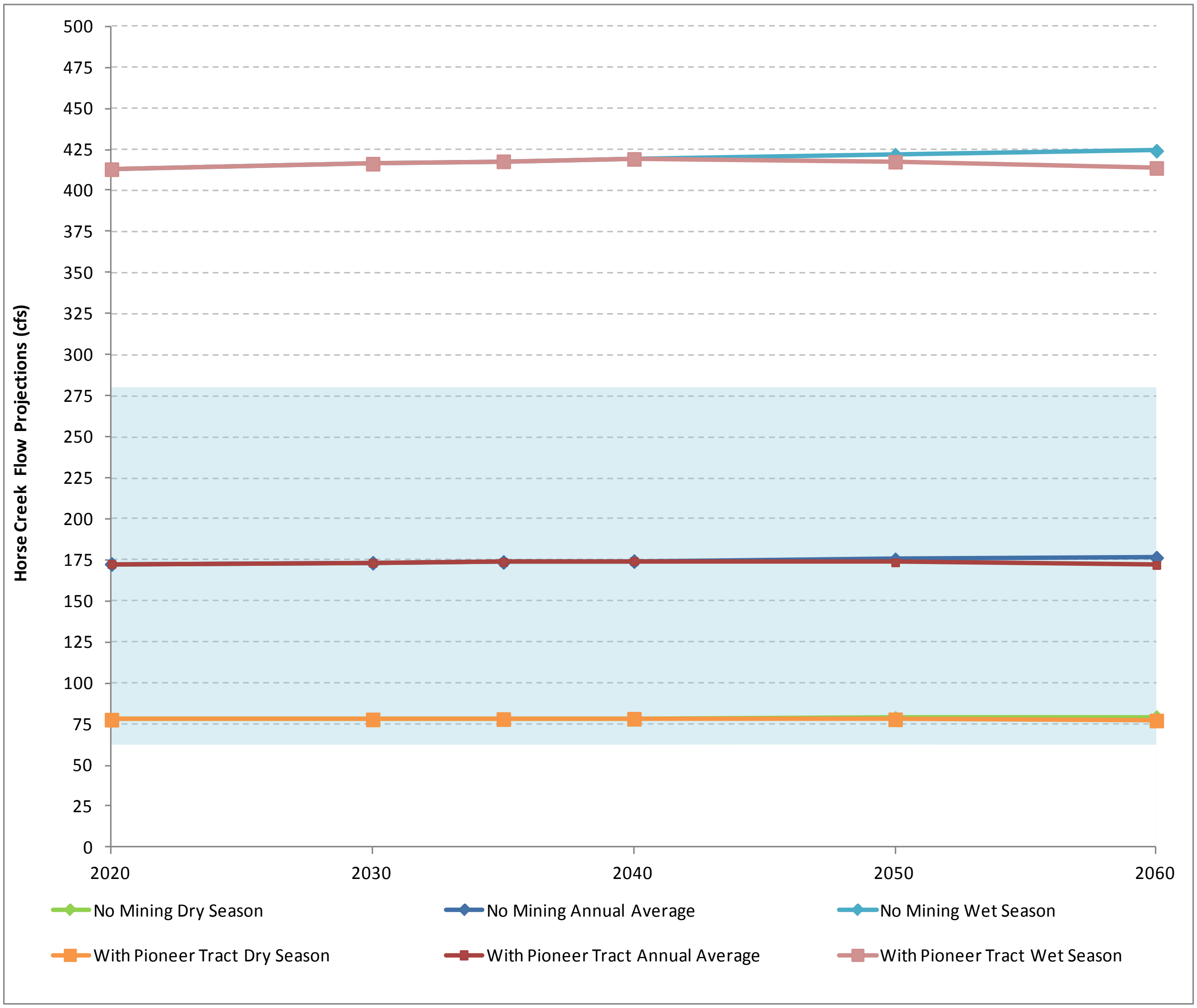
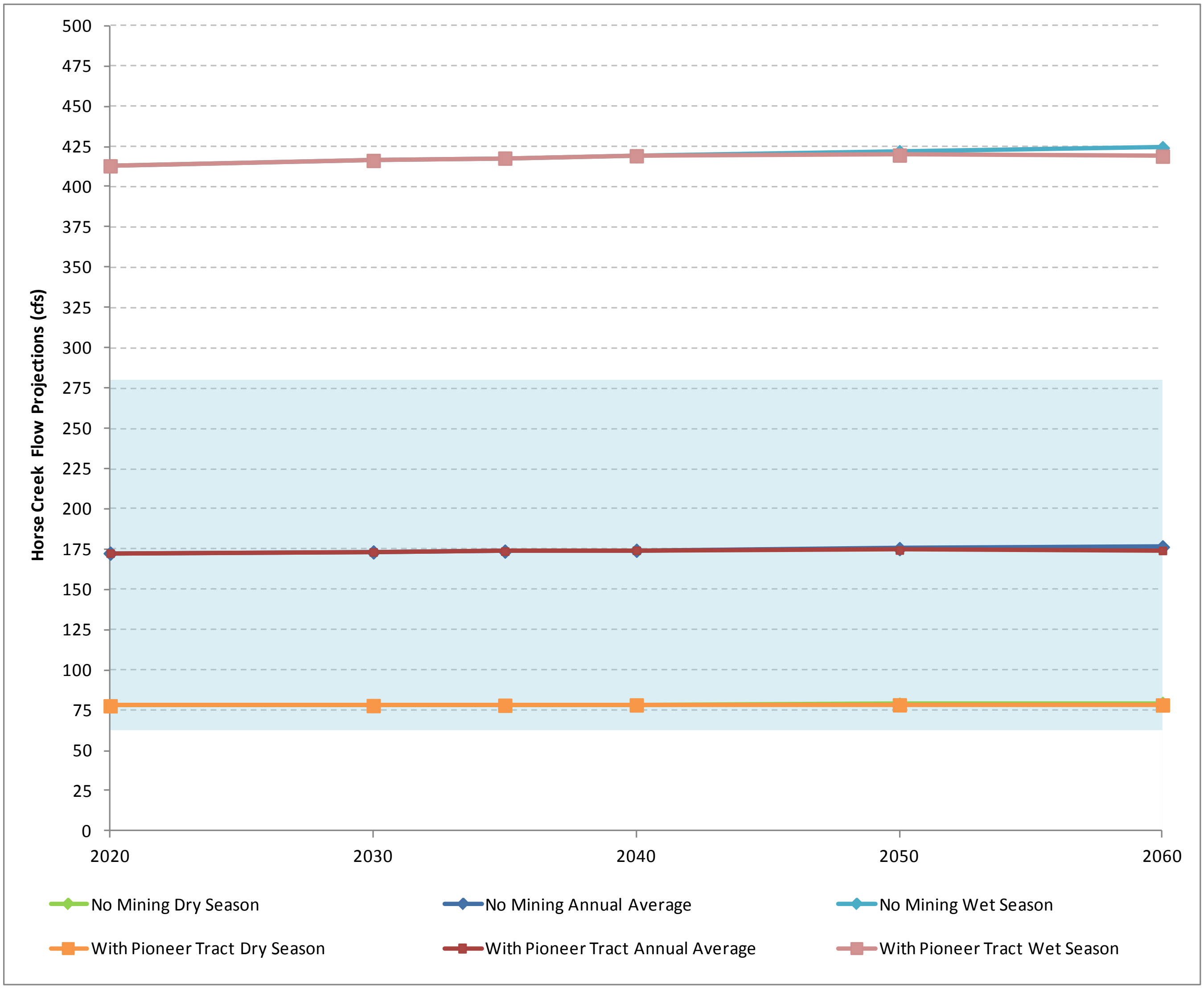


FIGURE 83
Horse Creek Annual Average and Seasonal Projected Flows for Average Annual Rainfall based on 50 Percent Capture of Excess Rainfall with and without the Pioneer Tract



Based on 100 percent capture of stormwater, Horse Creek may have an average annual flow of approximately 177 cfs without the Pioneer Tract and approximately 172 cfs with the Pioneer Tract by 2060. Assuming a 50 percent capture of stormwater, Horse Creek may have an average annual flow of approximately 174 cfs by 2060. This corresponds to a decrease in flow of 3 cfs when compared to the No Action Alternative conditions.

Figures 84 and 85 present the seasonal and annual average flows calculated for the Horse Creek gage station with and without the Pioneer Tract based on 100 percent capture and 50 percent capture of stormwater, respectively, during low rainfall conditions.

FIGURE 84

Horse Creek Annual Average and Seasonal Projected Flows for Low Annual Rainfall based on 100 Percent Capture of Excess Rainfall with and without the Pioneer Tract

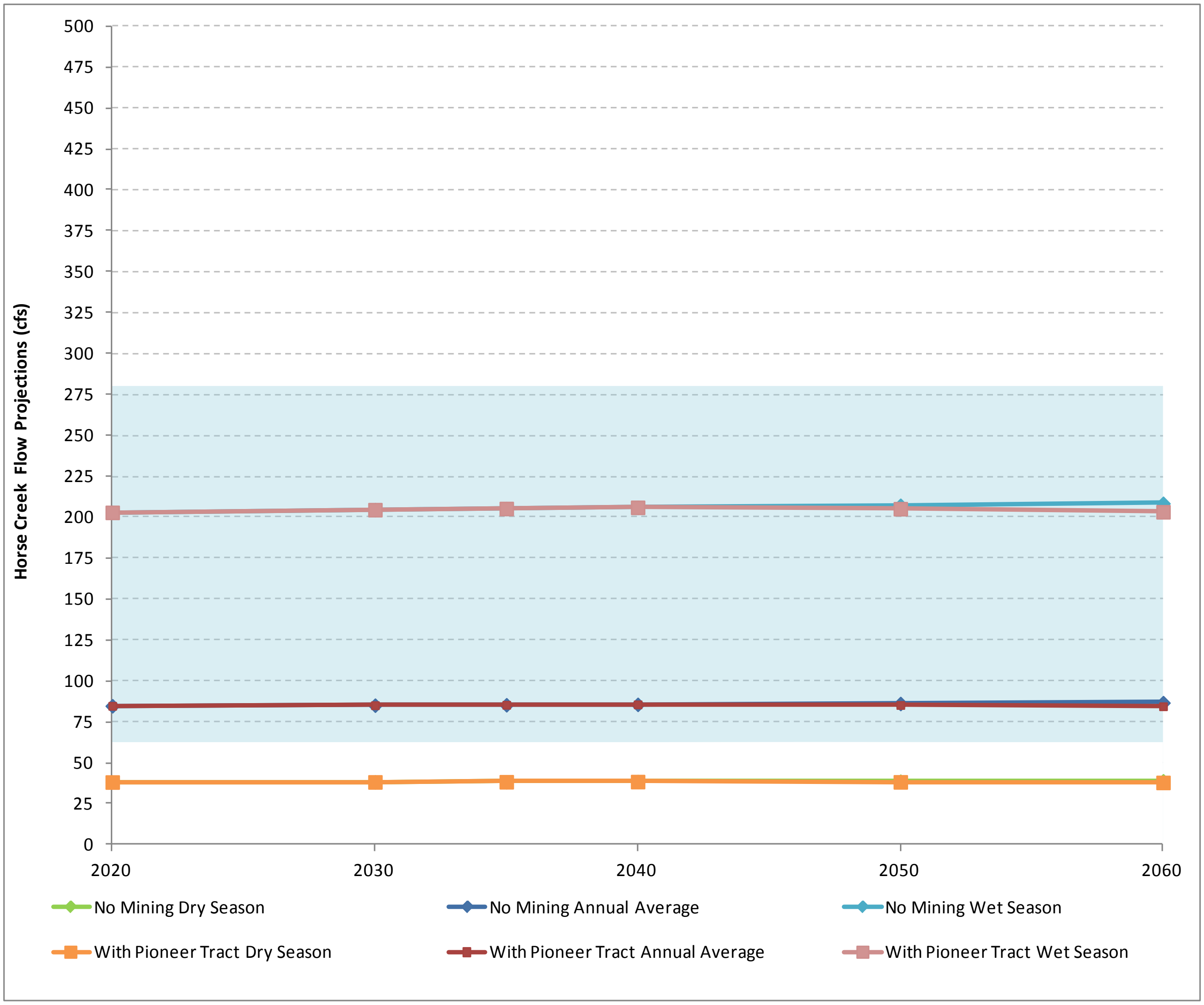
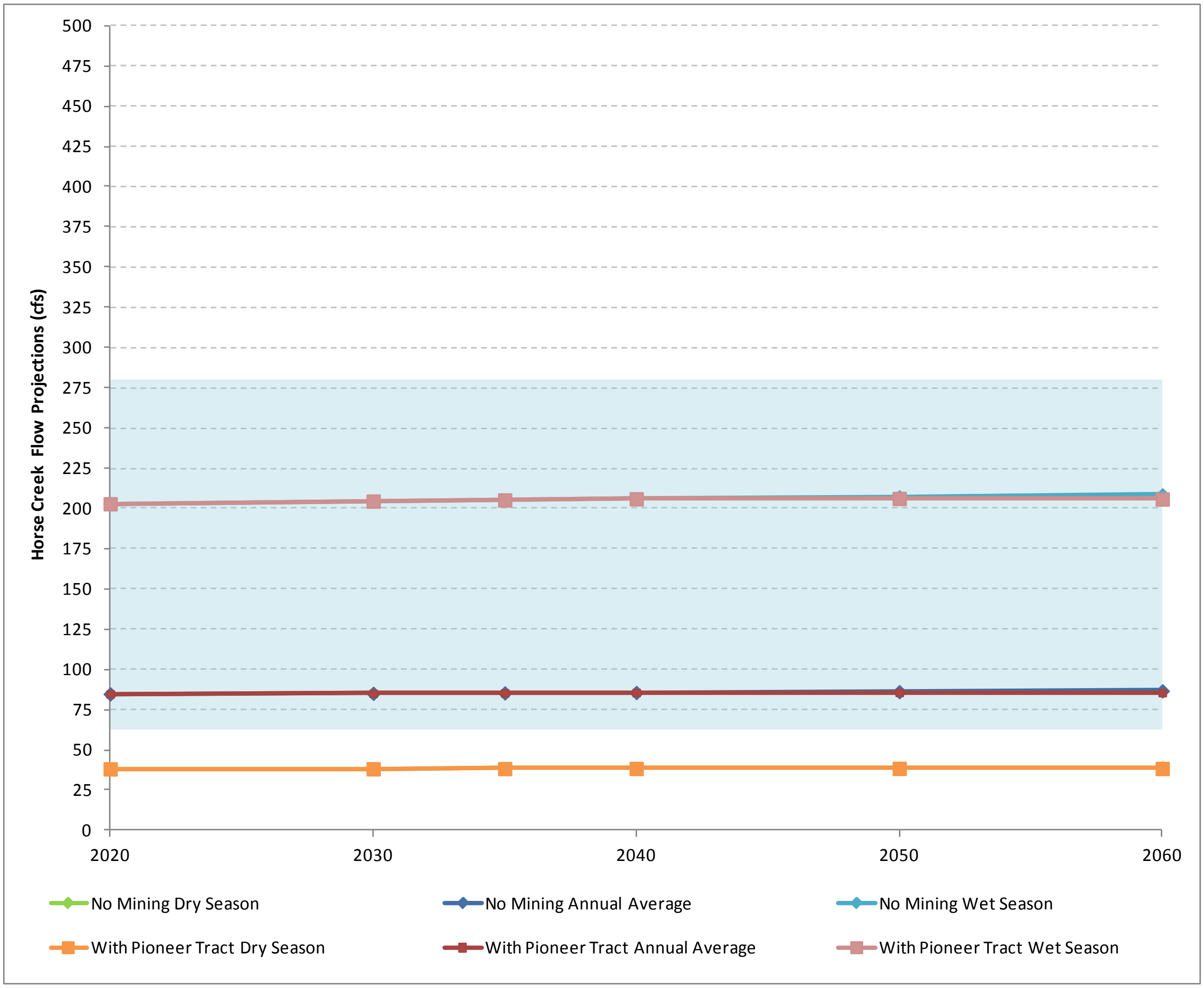


FIGURE 85

Horse Creek Annual Average and Seasonal Projected Flows for Low Annual Rainfall based on 50 Percent Capture of Excess Rainfall with and without Pioneer Tract



Based on 100 percent capture of stormwater, Horse Creek may have an average annual flow of approximately 87 cfs without the Pioneer Tract and approximately 85 cfs with the Pioneer Tract by 2060. Assuming a 50 percent capture of stormwater, Horse Creek may have an average annual flow of approximately 86 cfs. This corresponds to a decrease in flow of 1 cfs when compared to the No Action Alternative conditions.

5.7.2.2 Pioneer Tract Year 2048 Implementation Effects on the Peace River at Arcadia

Table 72 presents the flow and percent change from 2009 average annual and seasonal flows during an average rainfall year with 100 percent capture of stormwater in the capture area of the Pioneer Tract at the Peace River at Arcadia station. The maximum influence in this subwatershed was predicted to occur at 2060, right at the horizon of this analysis. Based on projected land use changes within the subwatershed and upstream subwatersheds, flows are predicted to increase through 2060. Annual average flow increases by approximately 9 percent by 2060, dry season flow increases by approximately 8 percent, and wet season flow increases by approximately 11 percent from 2009 levels. Considering the small percentage of land that would be mined compared to the total drainage area of this gage station, the changes in projected land use are predicted to have more of an impact on flow than the Pioneer Tract stormwater capture.

TABLE 72

Projected Flows and Percent Change from 2009 Flows during Average Rainfall Year and 100 Percent Capture at the Peace River at Arcadia Flow Station with the Pioneer Tract

	Annual Average Flow (cfs)	Annual Average Percent Change from 2009 Flows	Dry Season Average Flow (cfs)	Dry Season Average Percent Change from 2009 Flows	Wet Season Average Flow (cfs)	Wet Season Average Percent Change from 2009 Flows
2009	713	0%	328	0%	1,657	0%
2020	726	2%	332	1%	1,702	3%
2030	738	4%	336	3%	1,743	5%
2040	754	6%	343	5%	1,785	8%
2050	770	8%	350	7%	1,824	10%
2060	778	9%	353	8%	1,846	11%

Table 73 presents the flow and percent change from 2009 average annual and seasonal flows during an average rainfall year with 50 percent capture of stormwater in the capture area of the Pioneer Tract at the Peace River at Arcadia gage station. Similar to the 100 percent capture case, based on land use changes within the subwatershed and upstream subwatersheds, flows are predicted to increase during the Pioneer Tract mining period through 2060. Annual average flow increases by approximately 9 percent by 2060, dry season flow increases by approximately 8 percent, and wet season flow increases by approximately 12 percent from 2009 levels.

TABLE 73

Projected Flows and Percent Change from 2009 Flows during Average Rainfall Year and 50 Percent Capture at the Peace River at Arcadia Flow Station with the Pioneer Tract

	Annual Average Flow (cfs)	Annual Average Percent Change from 2009 Flows	Dry Season Average Flow (cfs)	Dry Season Average Percent Change from 2009 Flows	Wet Season Average Flow (cfs)	Wet Season Average Percent Change from 2009 Flows
2009	713	0%	328	0%	1,657	0%
2020	726	2%	332	1%	1,702	3%
2030	738	4%	336	3%	1,743	5%
2040	754	6%	343	5%	1,785	8%
2050	771	8%	350	7%	1,826	10%
2060	780	9%	354	8%	1,852	12%

The same evaluation was performed for a low rainfall year. Table 74 presents the flow and percent change from 2009 average annual and seasonal flows during a low rainfall year with 100 percent capture of stormwater in the capture area of the Pioneer Tract. Similar to the average rainfall scenarios, based on land use changes within the subwatershed and upstream subwatersheds, flows are predicted to increase during the Pioneer Tract mining period through 2060. By 2060 annual average flow increases by approximately 9 percent, dry season flow increases by approximately 8 percent, and wet season flow increases by approximately 12 percent from 2009 levels.

TABLE 74

Projected Flows and Percent Change from 2009 Flows during Low Rainfall Year and 100 Percent Capture at the Peace River at Arcadia Flow Station with the Pioneer Tract

	Annual Average Flow (cfs)	Annual Average Percent Change from 2009 Flows	Dry Season Average Flow (cfs)	Dry Season Average Percent Change from 2009 Flows	Wet Season Average Flow (cfs)	Wet Season Average Percent Change from 2009 Flows
2009	330	0%	152	0%	766	0%
2020	337	2%	154	1%	787	3%
2030	342	4%	156	3%	807	5%
2040	350	6%	159	5%	827	8%
2050	357	8%	162	7%	846	10%
2060	361	9%	164	8%	856	12%

Table 75 presents the flow and percent change from 2009 average annual and seasonal flows during a low rainfall year with 50 percent capture of stormwater in the capture area of the Pioneer Tract. Similar to the average rainfall year scenario, based on projected land use changes within the subwatershed and upstream subwatersheds, flows are predicted to increase during the Pioneer Tract mining period through 2060. Annual average flow increases by approximately 10 percent by 2060, dry season flow increases by approximately 8 percent, and wet season flow increases by approximately 12 percent from 2009 levels.

TABLE 75

Projected Flows and Percent Change from 2009 Flows during Low Rainfall Year and 50 Percent Capture at the Peace River at Arcadia Flow Station with the Pioneer Tract

	Annual Average Flow (cfs)	Annual Average Percent Change from 2009 Flows	Dry Season Average Flow (cfs)	Dry Season Average Percent Change from 2009 Flows	Wet Season Average Flow (cfs)	Wet Season Average Percent Change from 2009 Flows
2009	330	0%	152	0%	766	0%
2020	337	2%	154	1%	787	3%
2030	342	4%	156	3%	807	5%
2040	350	6%	159	5%	827	8%
2050	358	8%	163	7%	847	11%
2060	362	10%	164	8%	859	12%

To illustrate the effect on Peace River at Arcadia stream flow under the conditions and scenarios evaluated, the results are presented graphically and compared to the No Action Alternative conditions. Figures 86 and 87 present the seasonal and annual average flows calculated for the Peace River at Arcadia gage station with and without the Pioneer Tract based on 100 percent capture and 50 percent capture of stormwater, respectively, during average rainfall conditions.

FIGURE 86

Peace River at Arcadia Annual Average and Seasonal Projected Flows for Average Annual Rainfall based on 100 Percent Capture of Excess Rainfall with and without the Pioneer Tract

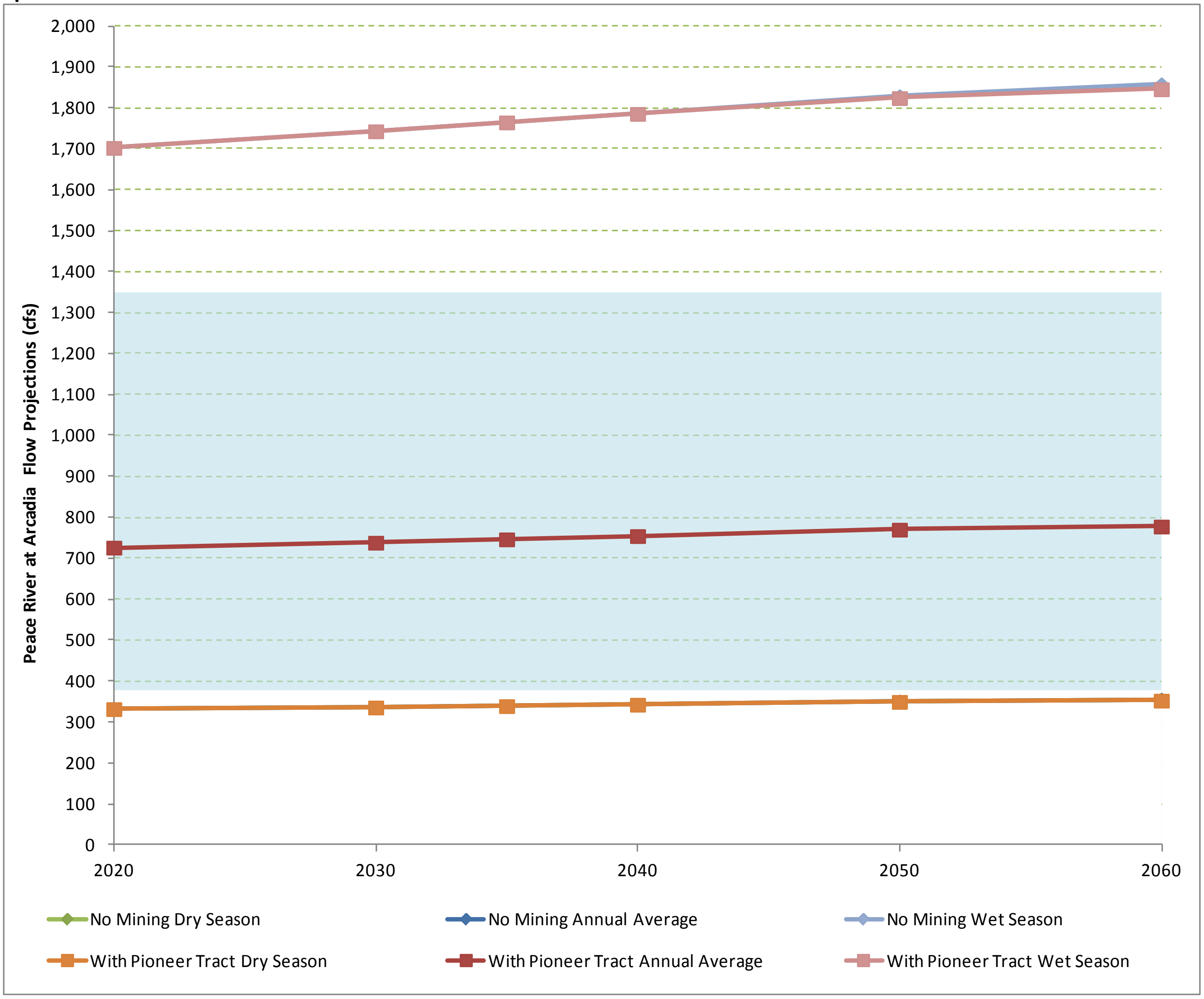
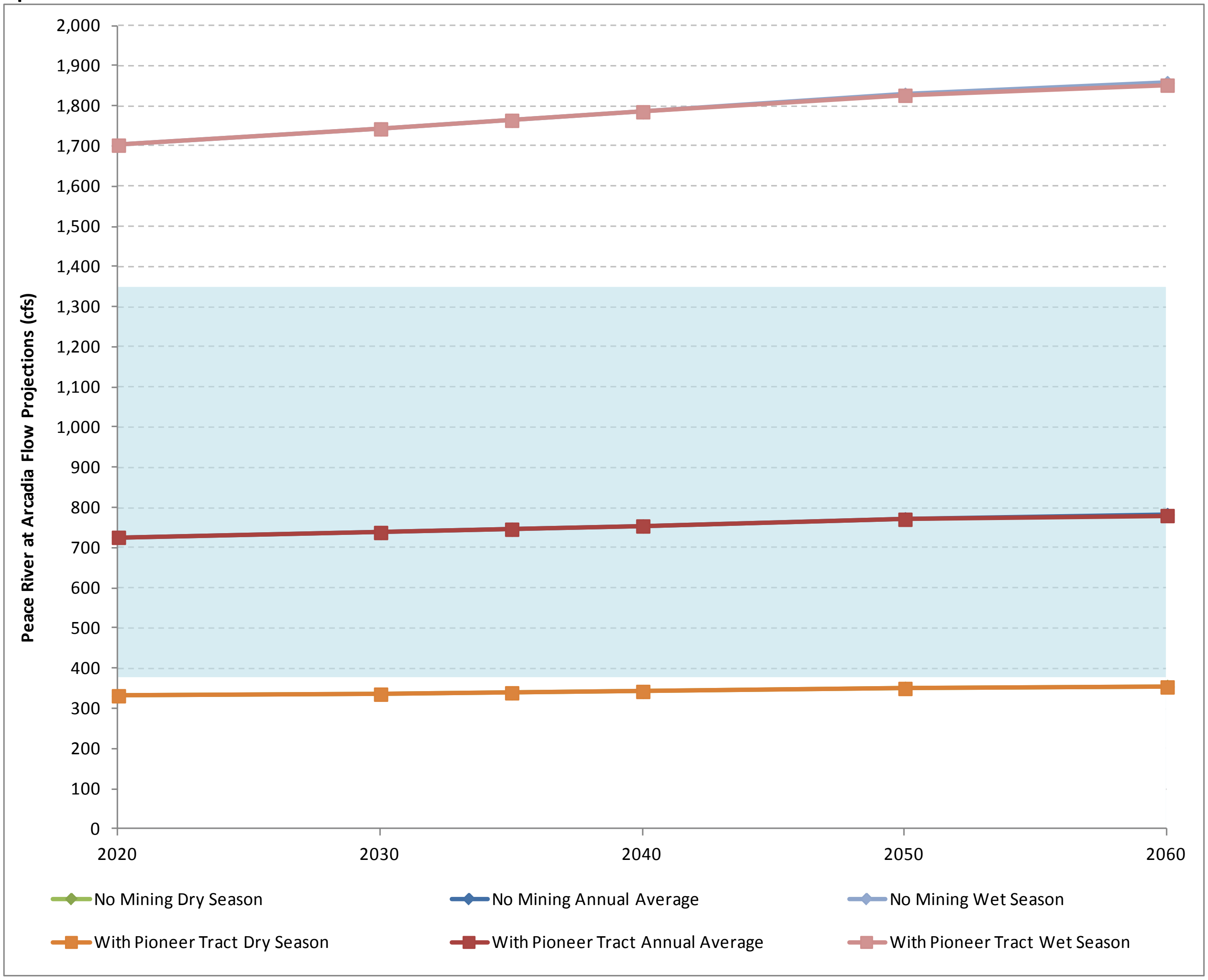


FIGURE 87

Peace River at Arcadia Annual Average and Seasonal Projected Flows for Average Annual Rainfall based on 50 Percent Capture of Excess Rainfall with and without the Pioneer Tract



The largest influences on annual average flow from the Peace River at Arcadia subwatershed during average rainfall conditions were predicted for 2060 based on the capture analysis. Based on 100 percent capture of stormwater, Peace River at Arcadia may have an average annual flow of approximately 783 cfs without the Pioneer Tract and approximately 778 cfs with the Pioneer Tract by 2060. Reductions in flow resulting from mine capture are expected to be less than the anticipated flow increases associated with projected changes in land use. Assuming a 50 percent capture of stormwater, Peace River at Arcadia may have an average annual flow of approximately 780 cfs as well, nearly the same as the 100 percent capture case.

Figures 88 and 89 present the seasonal and annual average flows calculated for the Peace River at Arcadia gage station with and without the Pioneer Tract based on 100 percent capture and 50 percent capture of stormwater, respectively, during low rainfall conditions.

FIGURE 88

Peace River at Arcadia Annual Average and Seasonal Projected Flows for Low Annual Rainfall based on 100 Percent Capture of Excess Rainfall with and without the Pioneer Tract

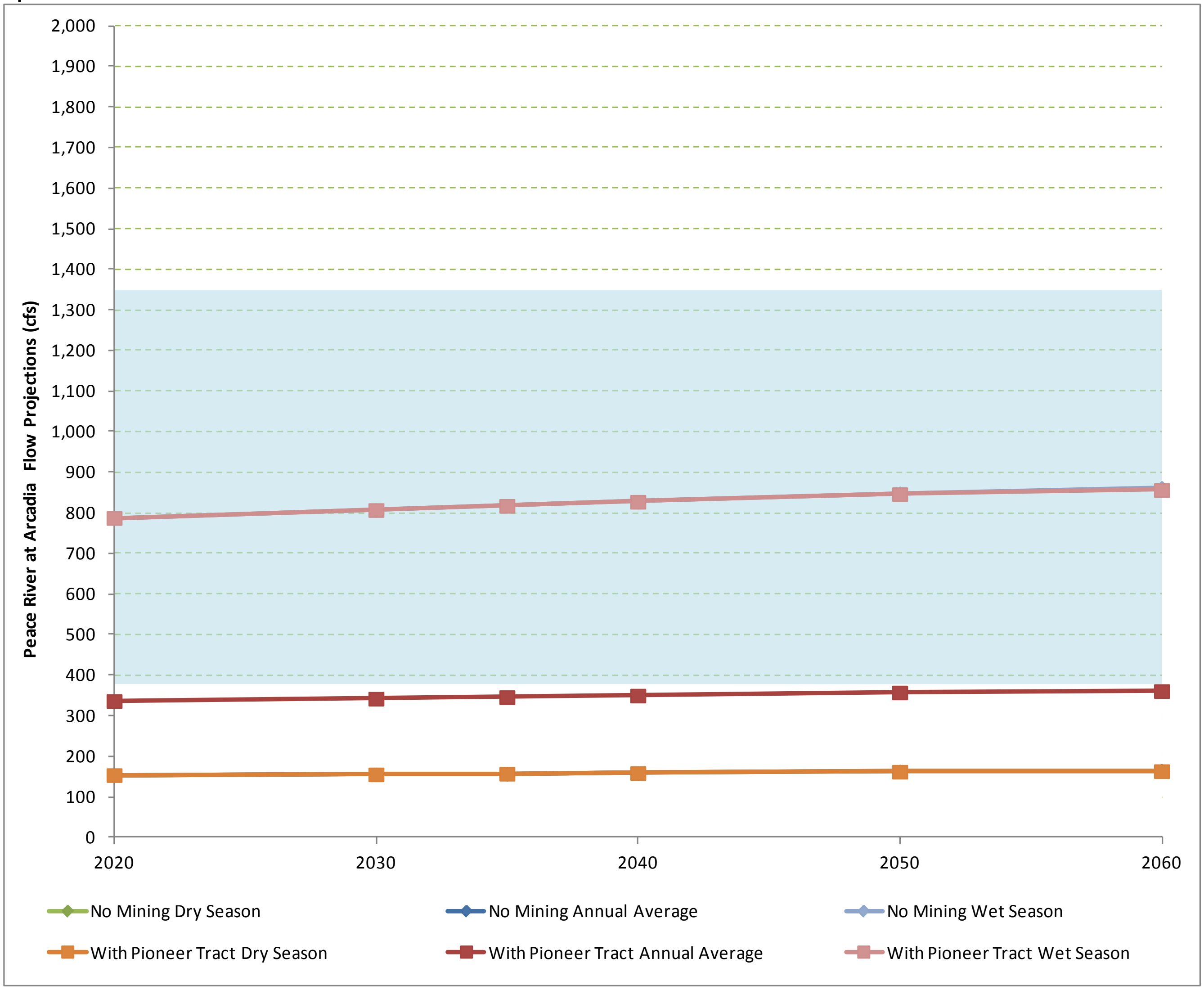
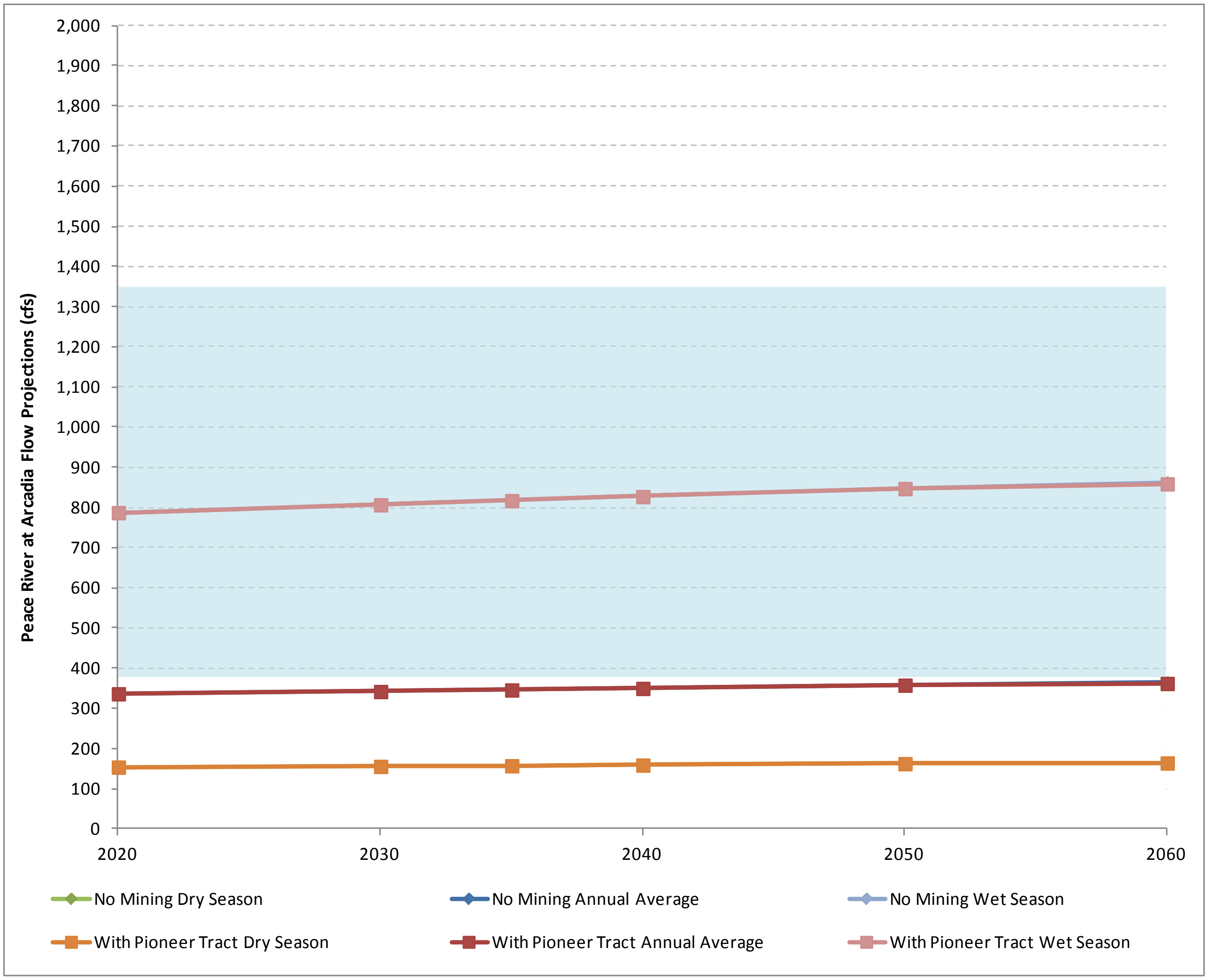


FIGURE 89

Peace River at Arcadia Annual Average and Seasonal Projected Flows for Low Annual Rainfall based on 50 Percent Capture of Excess Rainfall with and without Pioneer Tract



Results of the low rainfall year were similar to average rainfall conditions. Based on 100 percent capture of stormwater, Peace River at Arcadia may have an average annual flow of approximately 363 cfs without the Pioneer Tract and approximately 361 cfs with the Pioneer Tract by 2060. Assuming a 50 percent capture of stormwater, Peace River at Arcadia may have an average annual flow of approximately 362 cfs, nearly identical to the 100 percent capture case.

The Pioneer Tract supposes a small relative contribution to the flows measured at the Peace River at Arcadia gage station. The Pioneer Tract effect on flow quantities at this station would likely not be perceivable, particularly since flows are expected to increase as a result of projected land use changes in the Peace River at Arcadia drainage area.

5.8 Site A-2 and Site W-2 Offsite Alternative Impacts on Runoff Characteristics and Stream Flow

No Applicant has proposed either of these alternatives as a future mine project and no information exists as to whether they might be mine extensions or stand-alone new mines. Development of a mine plan for any of these alternatives to use in evaluating their effect on surface waters would be speculative. Therefore, quantitative analyses similar to those run for the Applicants' Preferred Alternatives were not performed. It may be assumed, since these parcels have conditions affecting surface water contributions that are similar to conditions of the other alternatives, that mining activities on these parcels would have similar results.

Site A-2 is east of the South Fort Meade Mine (existing) at the edge of the Peace River at Zolfo subwatershed. The GIS mapping analysis shows a very small portion of this alternative overlapping Charlie Creek's subwatershed boundary, but the area there is negligible and may be attributed to mapping accuracy. Site A-2 is approximately 8,189 acres with about 1,949 acres in hydric soils and wetlands (see AEIS, Table 2-4). If relatively large portions of the wetlands are not available for mining (i.e., avoided), then this alternative would be about the same size as the South Pasture Mine Extension. The South Pasture Mine Extension analysis showed small effects on the Peace River at Arcadia subwatershed, because it did not have much area in this subwatershed. Site A-2 is primarily in the Peace River at Zolfo subwatershed, but at its most eastern edge. This subwatershed tends to deliver less water downstream in dry periods because there is more seepage into the surficial aquifer from the streams north of Fort Meade (Metz and Lewelling, 2009). There is no information about potential mining in this alternative, so it is unknown how soon it could be developed. Given that Site A-2 is relatively small compared to other mines in the area, and that mining could be started after existing mines are reclaimed, one would expect similar small impacts from this alternative.

Site W-2 is in the upper Myakka River subwatershed and it is approximately 9,719 acres in size, but there are substantial areas of hydric soils and forested wetlands that may not be available for mining (see AEIS, Table 2-4). Assuming that relatively large portions of the wetlands may not be available for mining (i.e., avoided), Site W-2 is still about twice the size of the Wingate East Mine. Wingate East is expected to have a negligible effect on downstream surface water delivery, partially attributed to the wet dredge method used there. The hydrologic effect on offsite surface water delivery from Site W-2 would be different because dragline methods would more likely be used. However, the downstream impacts should be between the magnitude estimated for the South Pasture Mine Extension and Ona Mines on the Horse Creek subwatershed because Site W-2's area is about midway between these other sites. The maximum impacts for the two Horse Creek mines were in the 7- to 13-cfs range, respectively. When compared to the range of flow of the No Action Alternative results of about 250 to 270 cfs in the upper Myakka River subwatershed (depending on the year), the impact is small. In general, the SWFWMD is seeking ways of reducing surface water flow in the upper Myakka River, so one would expect that any small reduction would be a minor impact in this subwatershed.

5.9 Cumulative Impacts on Runoff Characteristics and Stream Flow

By calibrating the coefficients used to estimate future flows to observed data, the past cumulative impacts on subwatershed surface water yield are implicitly included in the baseline existing conditions. Estimating the future runoff conditions after existing mines are reclaimed also accounts for cumulative impacts considered in the AEIS. Aggregated impacts, that is, the surface water flows when multiple mines may be operating at once, are also provided in the AEIS and this section provides these results when multiple mines operate at the same time in each subwatershed, watershed, and the upper Charlotte Harbor estuary. The cumulative projected effect on flows in the subwatersheds was calculated by summing the impact of the individual capture areas analysis of mine alternatives in the subwatershed for each time interval. This section provides results for the Horse Creek subwatershed, Peace River at Arcadia subwatershed, Peace River subwatersheds combined, Myakka River combined, and then the Peace River and Myakka River combined flows into upper Charlotte Harbor.

5.9.1 Horse Creek Cumulative Impact

The impacts from three of the current actions (Desoto, Ona, and South Pasture Mine Extension) and the two reasonably foreseeable actions (Pioneer Tract and Pine Level/Keys Tract) that would operate with overlapping schedules[8] in the Horse Creek subwatershed were calculated by summing the impacts from the individual alternatives. The analysis was conducted for wet and dry seasons during an average rainfall year and for wet and

[8] Not all mines operate concurrently, especially for the Pioneer and Pine Level/Keys Tracts which follow the completion of Ona and Desoto mines, respectively.

dry seasons during a low rainfall year based on all of the stormwater within the capture area (i.e., active mine blocks) being captured (100 percent capture) and based on half of the net stormwater within the capture area being captured (50 percent capture). To illustrate the potential typical effect on stream flow, an average rainfall of 50 in/yr was applied as the average annual rainfall for the Peace River watershed.

Table 76 presents the flow and percent change from 2009 average annual and seasonal flows during an average rainfall year with 100 percent capture of stormwater in the capture areas of the three current and two foreseeable actions within this subwatershed. The maximum influence was predicted to occur around 2035 according to the capture analysis and flow results. Annual average flow decreases by approximately 17 percent by 2035, dry season flow decreases by approximately 18 percent, and wet season flow decreases by approximately 15 percent from 2009 levels. However, most mines are reclaimed by 2060, except for Pioneer and Pine Level/Keys Tracts implemented as mine extensions, and flows return nearly to the levels predicted for 2009.

TABLE 76

Projected Flows and Percent Change from 2009 Flows during Average Rainfall Year and 100 Percent Capture at the Horse Creek Flow Station with Three Current Actions and Two Foreseeable Actions within the Horse Creek Subwatershed

	Annual Average Flow (cfs)	Annual Average Percent Change from 2009 Flows	Dry Season Average Flow (cfs)	Dry Season Average Percent Change from 2009 Flows	Wet Season Average Flow (cfs)	Wet Season Average Percent Change from 2009 Flows
2009	171	0%	78	0%	404	0%
2020	171	0%	77	0%	410	1%
2030	147	-14%	66	-15%	353	-13%
2035	142	-17%	64	-18%	343	-15%
2040	151	-12%	68	-13%	363	-10%
2050	160	-6%	72	-7%	385	-5%
2060	169	-1%	76	-2%	406	1%

Table 77 presents the flow and percent change from 2009 average annual and seasonal flows during an average rainfall year with 50 percent capture of stormwater in the capture areas of the three current and two foreseeable actions within this subwatershed. The maximum influence was predicted to occur around 2035 according to the capture analysis and flow results. Annual average flow decreases by approximately 7 percent by 2035, dry season flow decreases by approximately 8 percent, and wet season flow decreases by approximately 6 percent from 2009 levels. However, by 2060 annual average and dry season flows return to the approximate levels predicted for 2009, with a slight increase for the wet season.

TABLE 77

Projected Flows and Percent Change from 2009 Flows during Average Rainfall Year and 50 Percent Capture at the Horse Creek Flow Station with Three Current Actions and Two Foreseeable Actions within the Horse Creek Subwatershed

	Annual Average Flow (cfs)	Annual Average Percent Change from 2009 Flows	Dry Season Average Flow (cfs)	Dry Season Average Percent Change from 2009 Flows	Wet Season Average Flow (cfs)	Wet Season Average Percent Change from 2009 Flows
2009	171	0%	78	0%	404	0%
2020	172	1%	78	0%	411	2%
2030	160	-6%	72	-7%	385	-5%
2035	159	-7%	71	-8%	382	-6%
2040	162	-5%	73	-6%	389	-4%
2050	168	-2%	75	-3%	403	0%
2060	173	1%	78	0%	415	3%

The same evaluation was performed for a low rainfall year. Low rainfall conditions were estimated as the 20th percentile of the annual rainfall totals for the period of record (i.e., 80 percent of the years had higher rainfall). For the Horse Creek cumulative analysis, this low rainfall calculation used 43 inches of rainfall per year.

Table 78 presents the flow and percent change from 2009 average annual and seasonal flows during a low rainfall year with 100 percent capture of stormwater in the capture area of the three current and two foreseeable actions within the Horse Creek subwatershed. The maximum influence was predicted to occur around 2035 according to the capture analysis and flow results. Similar to the average rainfall scenarios, based on land use changes within the subwatershed and upstream subwatersheds, annual average flow decreases by approximately 17 percent by 2035, dry season flow decreases by approximately 18 percent, and wet season flow decreases by approximately 15 percent from 2009 levels. However, by 2060 annual average flows return to the approximate levels predicted for 2009, with a slight decrease for the dry season and an increase for the wet season.

TABLE 78

Projected Flows and Percent Change from 2009 Flows during Low Rainfall Year and 100 Percent Capture at the Horse Creek Flow Station with Three Current Actions and Two Foreseeable Actions within the Horse Creek Subwatershed

	Annual Average Flow (cfs)	Annual Average Percent Change from 2009 Flows	Dry Season Average Flow (cfs)	Dry Season Average Percent Change from 2009 Flows	Wet Season Average Flow (cfs)	Wet Season Average Percent Change from 2009 Flows
2009	84	0%	38	0%	199	0%
2020	84	0%	38	0%	200	1%
2030	72	-14%	32	-15%	173	-13%
2035	70	-17%	31	-18%	168	-15%
2040	74	-12%	33	-13%	178	-10%
2050	79	-6%	35	-7%	189	-5%
2060	83	-1%	37	-2%	200	1%

Table 79 presents the flow and percent change from 2009 average annual and seasonal flows during a low rainfall year with 50 percent capture of stormwater in the capture area of three current and two foreseeable actions within the Horse Creek subwatershed. The maximum influence was predicted to occur around 2035 according to the capture analysis and flow results. Similar to the average rainfall scenarios, based on land use changes within the subwatershed and upstream subwatersheds, annual average flow decreases by approximately 7 percent by 2035, dry season flow decreases by approximately 8 percent, and wet season flow decreases by approximately 6 percent from 2009 levels. However, by 2060 annual average and dry season flows return to the approximate levels predicted for 2009, with a slight increase for the wet season.

TABLE 79
Projected Flows and Percent Change from 2009 Flows during Low Rainfall Year and 50 Percent Capture at the Horse Creek Flow Station with Three Current Actions and Two Foreseeable Actions within the Horse Creek Subwatershed

	Annual Average Flow (cfs)	Annual Average Percent Change from 2009 Flows	Dry Season Average Flow (cfs)	Dry Season Average Percent Change from 2009 Flows	Wet Season Average Flow (cfs)	Wet Season Average Percent Change from 2009 Flows
2009	84	0%	38	0%	199	0%
2020	85	1%	38	0%	202	2%
2030	79	-6%	35	-7%	189	-5%
2035	78	-7%	35	-8%	188	-6%
2040	80	-5%	36	-6%	191	-4%
2050	82	-2%	37	-3%	198	0%
2060	85	1%	38	0%	204	3%

To illustrate the effect on Horse Creek stream flow under the conditions and scenarios evaluated, the results are presented graphically and compared to the No Action Alternative conditions. Figures 90 and 91 present the dry season, wet season, and annual average flows calculated for the Horse Creek gage station with and without the three current and two foreseeable actions in operation for the 100 percent capture and the 50 percent capture cases, respectively.

FIGURE 90

Horse Creek Annual Average and Seasonal Projected Flows for Average Annual Rainfall based on 100 Percent Capture of Excess Rainfall with and without the Three Current Actions and Two Foreseeable Actions

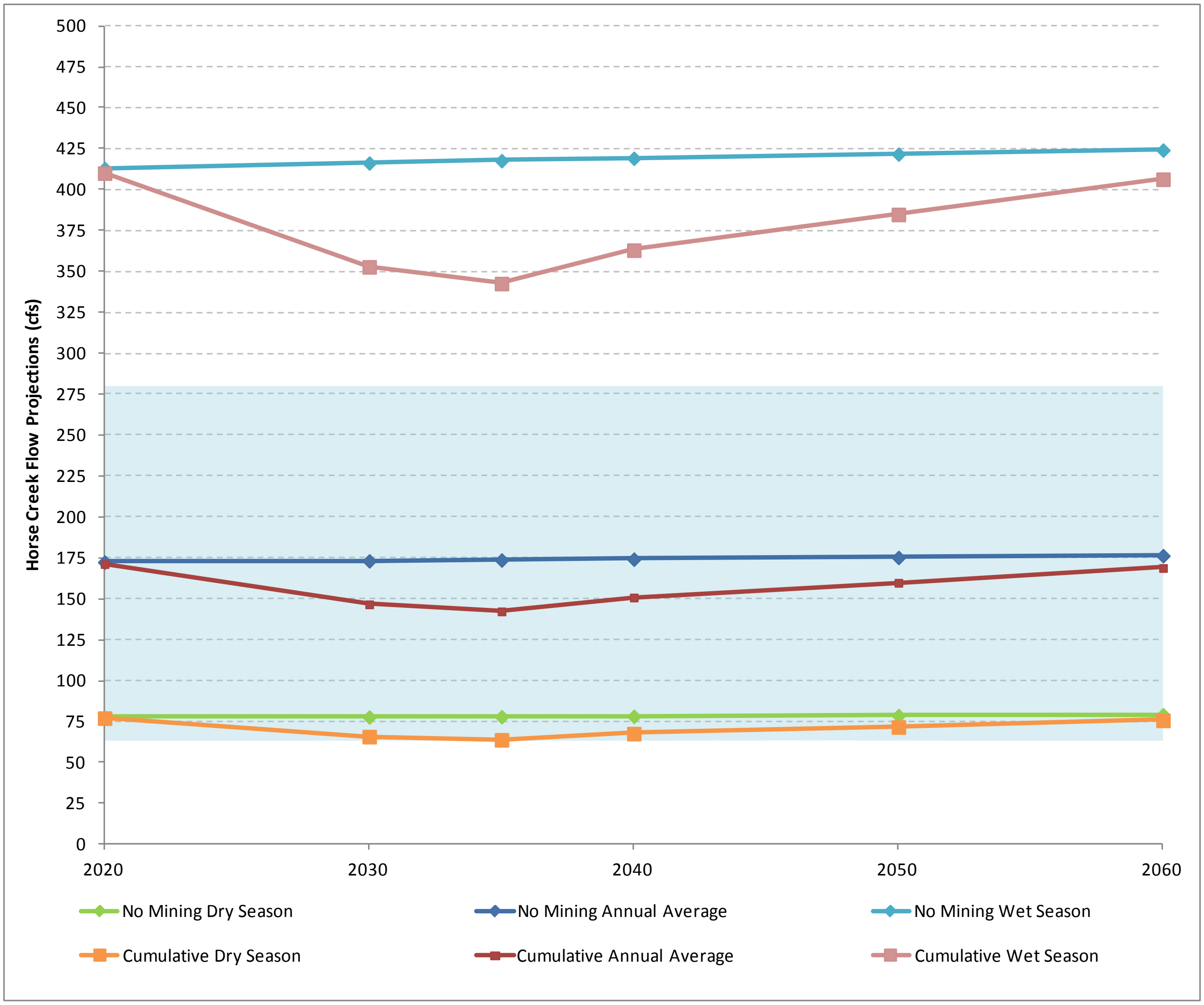
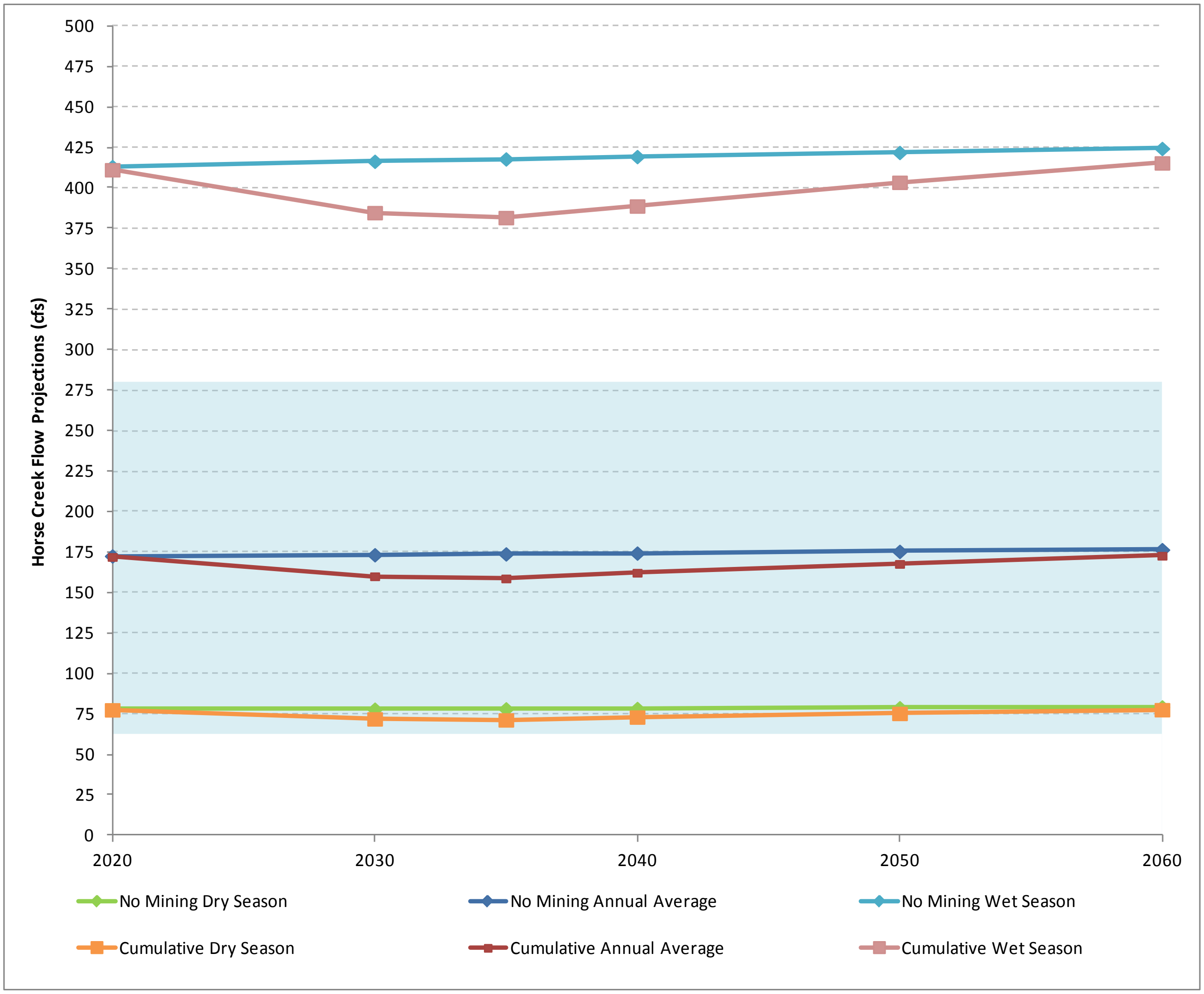


FIGURE 91

Horse Creek Seasonal and Annual Average Projected Flows for 50 Percent Capture of Excess Rainfall Case during Average Annual Rainfall with and without the Three Current Actions and Two Foreseeable Actions



The largest influences on annual average flow from the Horse Creek subwatershed during average rainfall conditions were predicted to occur around 2035. Based on 100 percent capture of stormwater, Horse Creek may have an average annual flow of approximately 174 cfs without mining and approximately 142 cfs with mining by 2035. Assuming a 50 percent capture of stormwater, Horse Creek may have an average annual flow of approximately 159 cfs.

Figures 92 and 93 present the seasonal and annual average flows calculated for the Horse Creek gage station with and without the three current and two foreseeable actions in operation for the 100 percent capture and the 50 percent capture cases, respectively, during low rainfall conditions.

FIGURE 92

Horse Creek Seasonal and Annual Average Projected Flows for 100 Percent Capture of Excess Rainfall Case during Low Annual Rainfall with and without the Three Current Actions and Two Foreseeable Actions

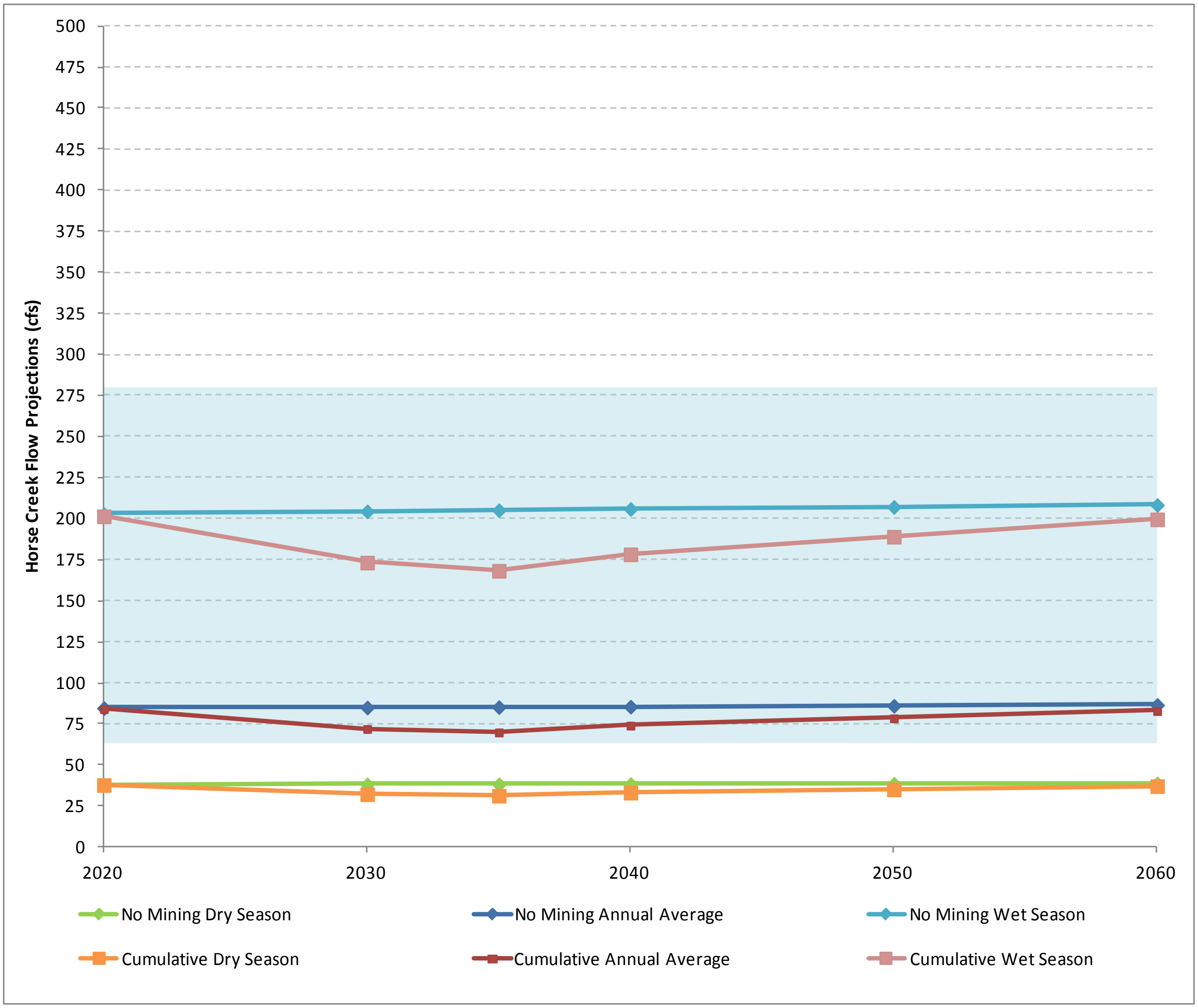
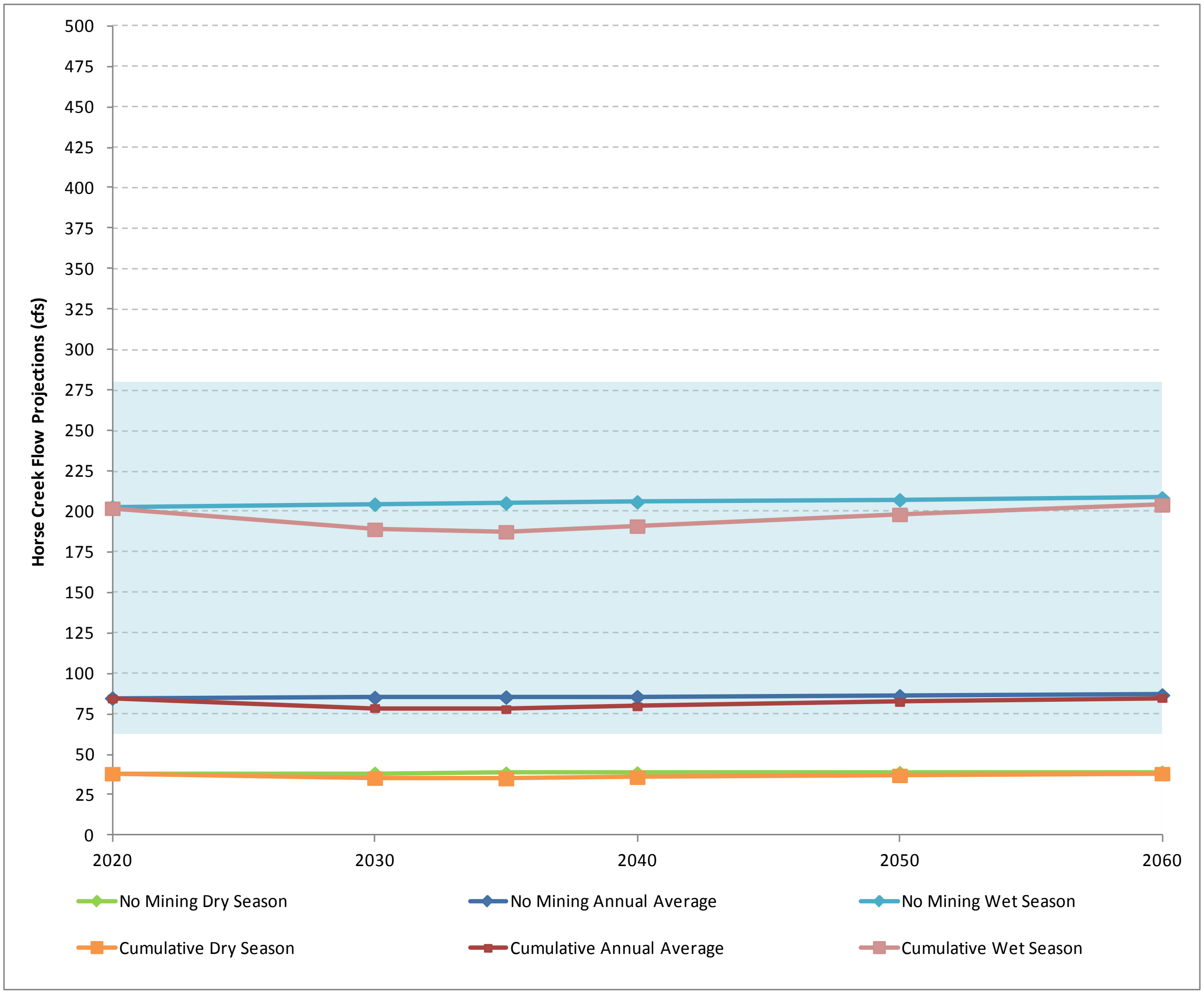


FIGURE 93

Horse Creek Seasonal and Annual Average Projected Flows for 50 Percent Capture of Excess Rainfall Case during Low Annual Rainfall with and without the Three Current Actions and Two Foreseeable Actions



The largest influence on annual average flow from the Horse Creek subwatershed during low rainfall conditions was predicted to occur around 2035. Based on 100 percent capture of stormwater, Horse Creek may have an average annual flow of approximately 85 cfs without mining and approximately 70 cfs with mining by 2035. Assuming a 50 percent capture of stormwater, Horse Creek may have an average annual flow of approximately 78 cfs.

There are no SWFWMD minimum flow or levels (MFLs) established for Horse Creek to which this reduction can be compared. Through the monitoring program and other provisions in FDEP permits, if it is determined that there is an impact to the creek, the Applicants would need to address them in a manner and on a schedule acceptable to the regulators (both state and federal).

5.9.2 Peace River at Arcadia Cumulative Impact

The impact from the three current actions (Desoto, Ona, and South Pasture Mine Extension) and the one foreseeable future action (Pioneer Tract) operating concurrently was calculated by evaluating the cumulative effects on the runoff coefficients in the Peace River at Arcadia subwatershed using the same process used for Horse Creek. The analysis was conducted for wet and dry seasons during an average rainfall year and for wet and dry seasons during a low rainfall year based on all of the runoff within the capture area being captured

(100 percent capture) and based on half of the runoff within the capture area being captured (50 percent capture). To illustrate the potential impacts on stream flow, an average rainfall of 50 in/yr was applied as the average annual rainfall for the Peace River watershed.

Table 80 presents the flow and percent change from 2009 average annual and seasonal flows during an average rainfall year with 100 percent capture of stormwater in the capture areas of the three current actions and one foreseeable action within this watershed. The maximum influence was predicted to occur beyond 2060 according to the capture analysis. Therefore, the 2060 results are reported as the maximum impact period. Even when considering the three current actions and one foreseeable action within the Peace River at Arcadia subwatershed, projected land use changes in this subwatershed and upstream subwatersheds result in increases in flow. Most mines are reclaimed by 2060, except for Pioneer and Pine Level/Keys Tracts implemented as mine extensions, and the projected flows on average increase by 9 percent, with an increase of 7 percent in the dry season and an increase of 11 percent in the wet season when compared to 2009 flows.

TABLE 80

Projected Flows and Percent Change from 2009 Flows during Average Rainfall Year and 100 Percent Capture at the Peace River at Arcadia Flow Station with Three Current Actions and One Foreseeable Action

	Annual Average Flow (cfs)	Annual Average Percent Change from 2009 Flows	Dry Season Average Flow (cfs)	Dry Season Average Percent Change from 2009 Flows	Wet Season Average Flow (cfs)	Wet Season Average Percent Change from 2009 Flows
2009	713	0%	328	0%	1,657	0%
2020	726	2%	332	1%	1,701	3%
2030	735	3%	334	2%	1,735	5%
2040	750	5%	340	4%	1,779	7%
2050	769	8%	348	6%	1,820	10%
2060	777	9%	352	7%	1,846	11%

Table 81 presents the flow and percent change from 2009 average annual and seasonal flows during an average rainfall year with 50 percent capture of stormwater in the capture areas of the three current actions and one foreseeable action within this watershed. By 2060 the projected annual average flow increases by 9 percent when compared to 2009 levels, with an increase of 8 percent in the dry season and an increase of 12 percent in the wet season. These results were similar to those predicted with the 100 percent capture case. The total footprints of the three current and one foreseeable action encompass a small percentage of the total drainage area for this gage station, so the changes in projected land use have a far larger impact on flow than mining.

The same evaluation was performed for a low rainfall year (43 inches per year). Table 82 presents the flow and percent change from 2009 average annual and seasonal flows during a low rainfall year with 100 percent capture of stormwater in the capture area of the three current and one foreseeable action within the Peace River at Arcadia subwatershed. By 2060 the projected annual average flow increases by 9 percent, with an increase of 8 percent in the dry season and an increase of 12 percent in the wet season when compared to 2009 flows.

Table 83 presents the flow and percent change from 2009 average annual and seasonal flows during a low rainfall year with 50 percent capture of stormwater in the capture area of the three current and one foreseeable action within the Peace River at Arcadia subwatershed. By 2060 the projected annual average flow increases by 10 percent, with an increase of 8 percent in the dry season and an increase of 12 percent in the wet season. Similar to the average rainfall analysis, the total footprints of the three current and one foreseeable action encompass a small percentage of the total drainage area for this gage station, so the changes in projected land use have a far larger effect on flow than mining.

TABLE 81

Projected Flows and Percent Change from 2009 Flows during Average Rainfall Year and 50 Percent Capture at the Peace River at Arcadia Flow Station with Three Current Actions and One Foreseeable Action

	Annual Average Flow (cfs)	Annual Average Percent Change from 2009 Flows	Dry Season Average Flow (cfs)	Dry Season Average Percent Change from 2009 Flows	Wet Season Average Flow (cfs)	Wet Season Average Percent Change from 2009 Flows
2009	713	0%	328	0%	1,657	0%
2020	726	2%	332	1%	1,702	3%
2030	737	3%	335	2%	1,739	5%
2040	753	6%	342	4%	1,782	8%
2050	770	8%	350	7%	1,825	10%
2060	780	9%	354	8%	1,852	12%

TABLE 82

Projected Flows and Percent Change from 2009 Flows during Low Rainfall Year and 100 Percent Capture at the Peace River at Arcadia Flow Station with Three Current Actions and One Foreseeable Action

	Annual Average Flow (cfs)	Annual Average Percent Change from 2009 Flows	Dry Season Average Flow (cfs)	Dry Season Average Percent Change from 2009 Flows	Wet Season Average Flow (cfs)	Wet Season Average Percent Change from 2009 Flows
2009	330	0%	152	0%	766	0%
2020	336	2%	154	1%	787	3%
2030	341	3%	155	2%	804	5%
2040	348	5%	158	4%	825	8%
2050	356	8%	162	6%	845	10%
2060	361	9%	163	8%	856	12%

TABLE 83

Projected Flows and Percent Change from 2009 Flows during Low Rainfall Year and 50 Percent Capture at the Peace River at Arcadia Flow Station with the Three Current Actions and One Foreseeable Action

	Annual Average Flow (cfs)	Annual Average Percent Change from 2009 Flows	Dry Season Average Flow (cfs)	Dry Season Average Percent Change from 2009 Flows	Wet Season Average Flow (cfs)	Wet Season Average Percent Change from 2009 Flows
2009	330	0%	152	0%	766	0%
2020	336	2%	154	1%	787	3%
2030	341	3%	155	2%	805	5%
2040	349	6%	159	5%	826	8%
2050	358	8%	162	7%	846	11%
2060	362	10%	164	8%	859	12%

To illustrate the effect on Peace River at Arcadia stream flow under the conditions and scenarios evaluated, the results are presented graphically and compared to the No Action Alternative conditions. Figures 94 and 95 present the dry season, wet season, and annual average flows calculated for the Peace River at Arcadia gage station with and without the three current and one foreseeable action in operation for the 100 percent capture and the 50 percent capture cases, respectively.

FIGURE 94

Peace River at Arcadia Annual Average and Seasonal Projected Flows for Average Annual Rainfall based on 100 Percent Capture of Excess Rainfall with and without the Three Current Actions and One Foreseeable Action

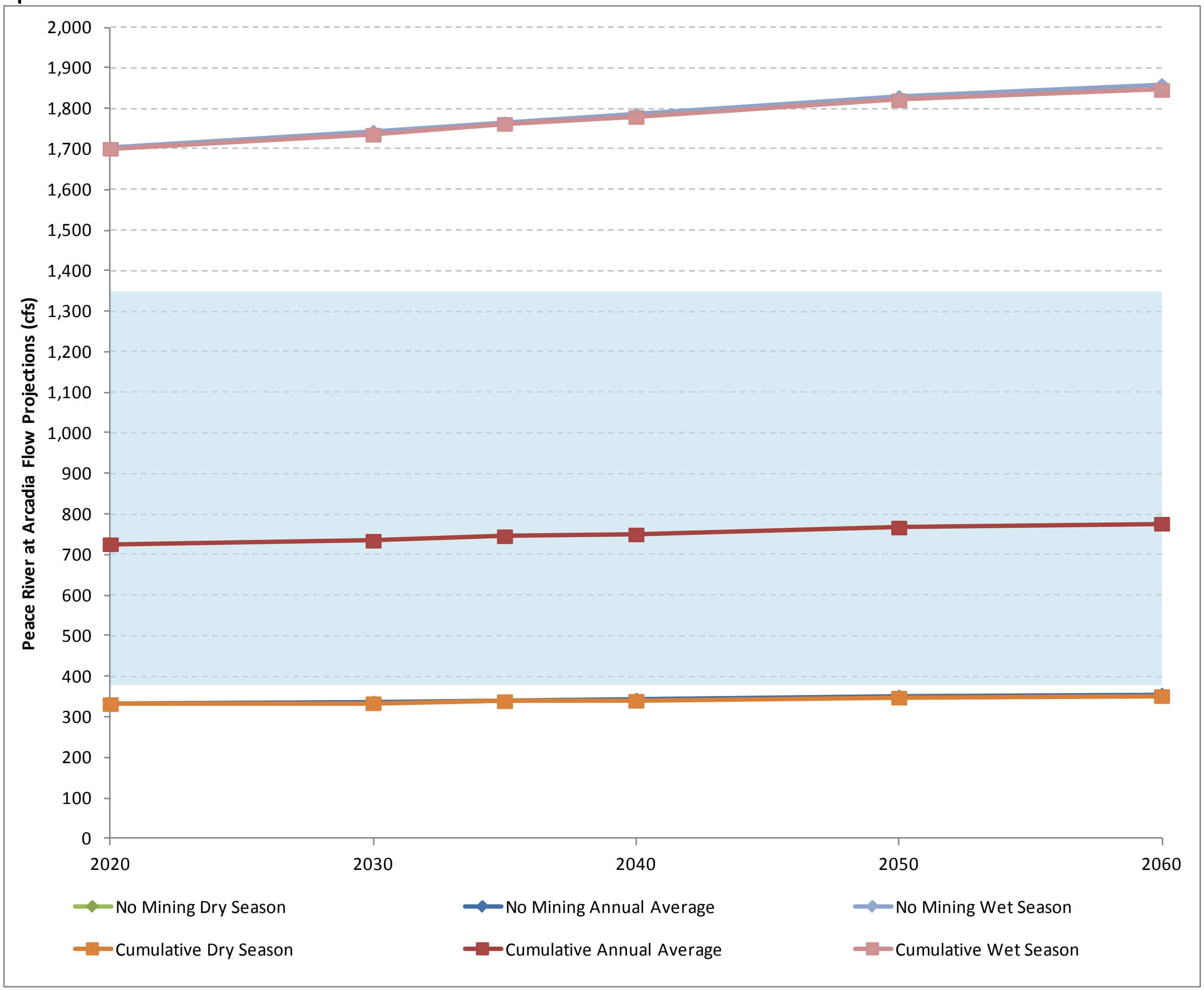
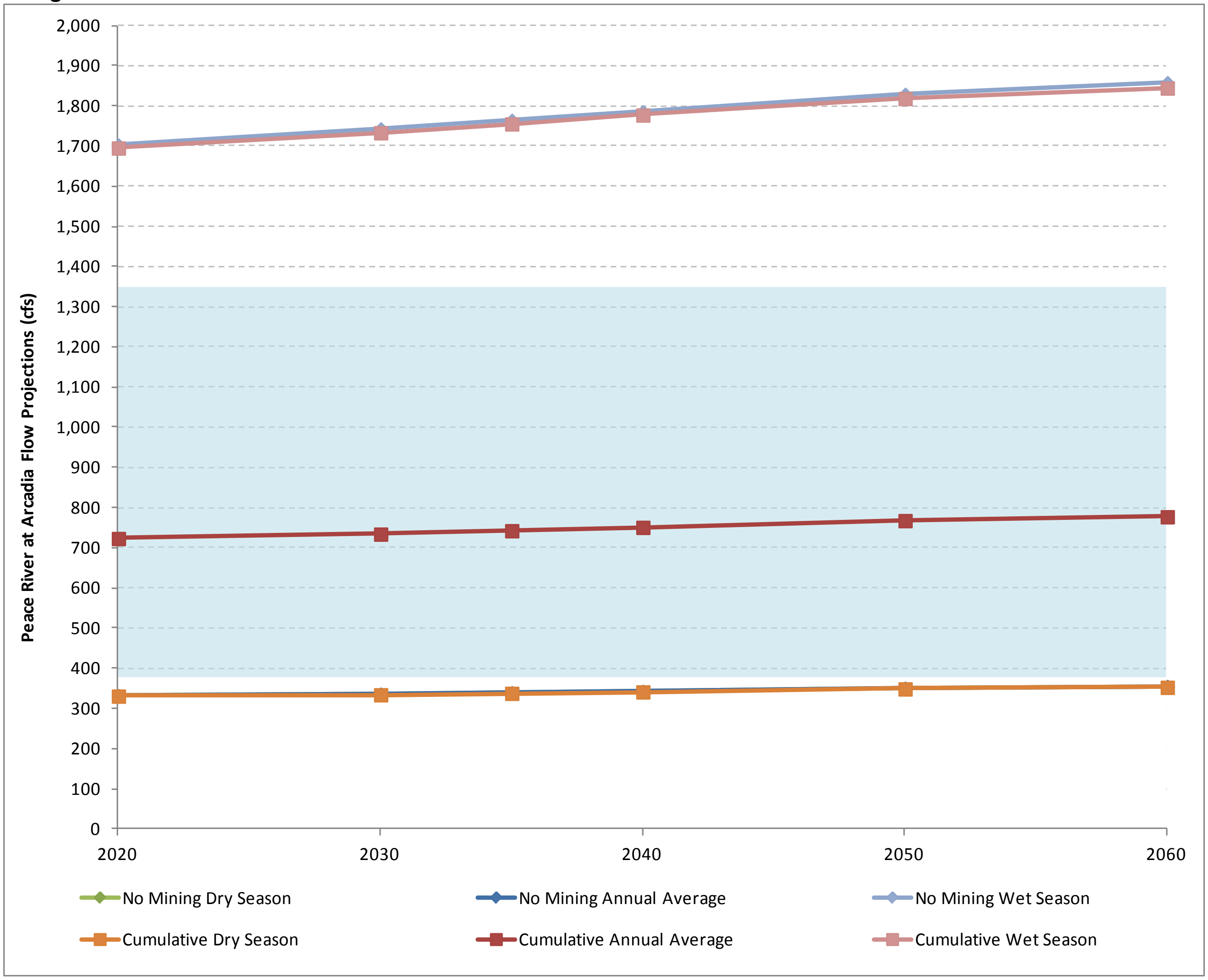


FIGURE 95

Peace River at Arcadia Seasonal and Annual Average Projected Flows for 50 Percent Capture of Excess Rainfall Case during Average Annual Rainfall with and without the Three Current Actions and One Foreseeable Action



The largest influence on annual average flow from the Peace River at Arcadia subwatershed during average rainfall conditions was predicted to occur after 2060 based on the capture analyses. Based on 100 percent capture of stormwater, Peace River at Arcadia may have an average annual flow of approximately 783 cfs without mining and approximately 776 cfs with mining by 2060. Assuming a 50 percent capture of stormwater, Peace River at Arcadia may have an average annual flow of approximately 780 cfs. This suggests that the mine capture within this subwatershed has a marginal effect on stream flow when considering the changes in land use within this subwatershed and upstream subwatersheds.

Figures 96 and 97 present the seasonal and annual average flows calculated for the Peace River at Arcadia gage station with and without the mines Pioneer Tract based on 100 percent capture and 50 percent capture of stormwater, respectively, during low rainfall conditions.

FIGURE 96

Peace River at Arcadia Seasonal and Annual Average Projected Flows for 100 Percent Capture of Excess Rainfall Case during Low Annual Rainfall with and without the Three Current Actions and One Foreseeable Action

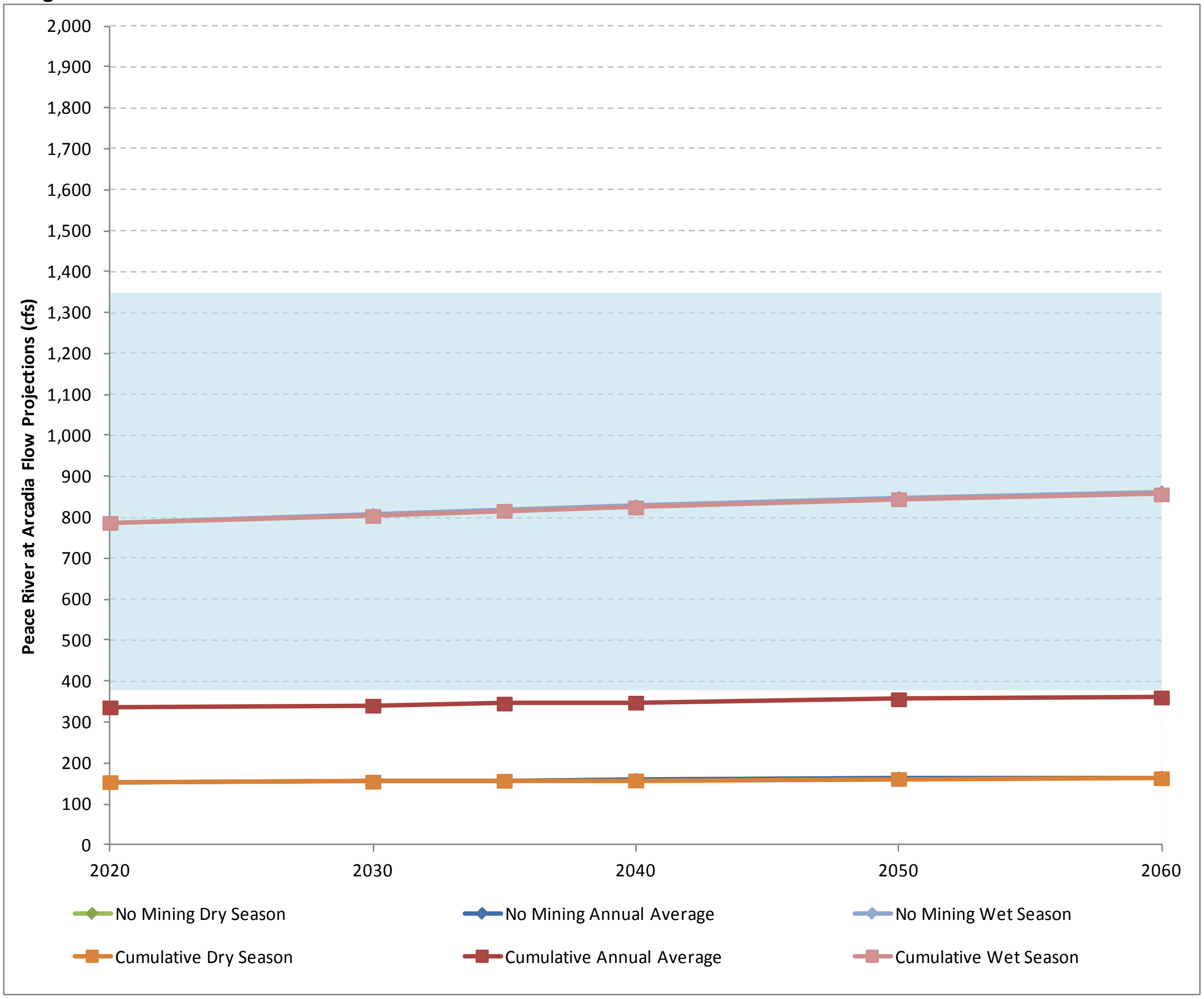
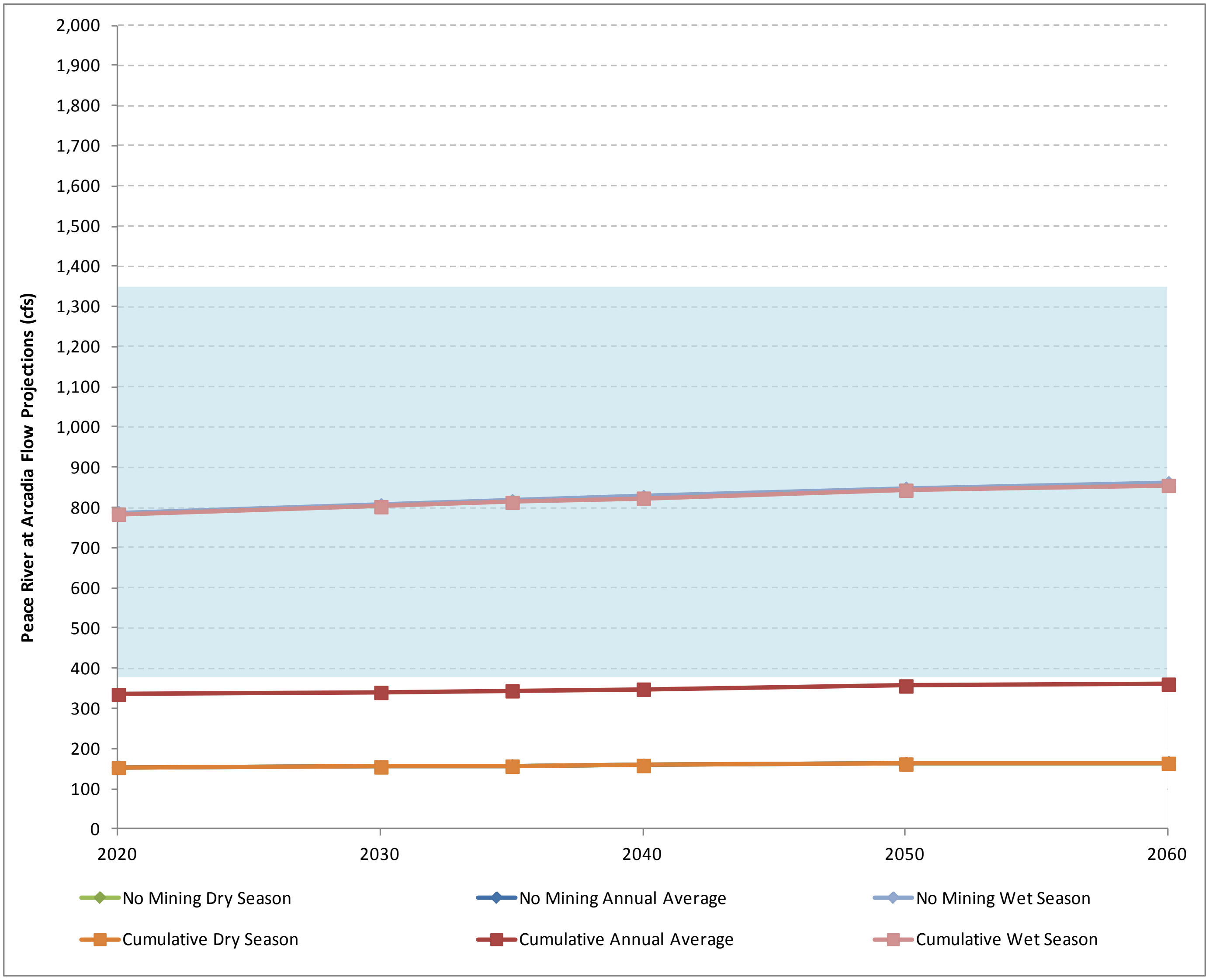


FIGURE 97

Peace River at Arcadia Seasonal and Annual Average Projected Flows for 50 Percent Capture of Excess Rainfall Case during Low Annual Rainfall with and without the Three Current Actions and One Foreseeable Action



The largest influence on annual average flow from the Peace River at Arcadia subwatershed during low rainfall conditions was predicted to after 2060 based on the mine capture analyses. Based on 100 percent capture of stormwater, Peace River at Arcadia may have an average annual flow of approximately 363 cfs without mining and approximately 361 cfs with mining between 2030 and 2040. Assuming a 50 percent capture of stormwater, Peace River at Arcadia may have an average annual flow of approximately 362 cfs. The MFL for Peace River at Arcadia is 67 cfs, which is much lower than the predicted flow at the lowest 20^{th} percentile annual rainfall. The three current and one foreseeable action in this subwatershed have very minor impact at the gage location and are would not be expected to reduce flow by a level that could be easily detected.

5.9.3 Charlotte Harbor Estuary Cumulative Impacts

The deliveries of flow to the upper Charlotte Harbor Estuary from both the Peace River and Myakka River watersheds were projected by applying the runoff coefficient approach to the river watersheds at the downstream USGS stations. There are some additional contributing uplands downstream of these gages that also contribute flow to the estuary. The flow listed in this subsection is therefore not an estimate of the total flow, but only from those freshwater sources that are discussed in the analysis and Shell Creek in the Peace River watershed and the Big Slough Basin and upper Myakka River subwatershed (USGS gage near Sarasota) in the Myakka River watershed. The lower Charlotte Harbor Estuary area (near Fort Myers) is more heavily influenced by the Caloosahatchee River and is not included here as it is not within the scope of the AEIS. Consequently, the flows presented here are estimates of "most" of the flow from the respective watershed. Percent changes reported are only for the areas contributing to the estuary within the computations.

The impacts to flow from the four current actions and the two reasonably foreseeable actions were estimated by summing the capture areas in each subwatershed. Flow impacts were estimated by using the same capture curves used for the individual subwatershed assessments. This assessment was applied for cases of 100 percent capture of stormwater within the mine capture areas and for 50 percent capture of stormwater within the mine capture areas. Estimates were performed seasonally and for annual average flows for average rainfall conditions and for low rainfall conditions.

5.9.3.1 Peace River Contributions to Upper Charlotte Harbor Estuary Cumulative Impact

Table 84 presents the Peace River contributions to the upper Charlotte Harbor Estuary and percent change from 2009 seasonal and annual average flows for the 100 percent capture of stormwater from the mining capture areas under average rainfall conditions (50 inches per year). The maximum influence was predicted to occur between 2030 and 2040 according to the capture analysis. Annual average flow increases by approximately 2 to 4 percent during the period of 2030 and 2040, dry season flow increases by approximately 1 to 4 percent, and wet season flow increases by approximately 3 to 6 percent from 2009 levels. Even when considering three current actions and two foreseeable actions, projected land use changes in the two watersheds result in increases in future flow. By 2060 most mines are reclaimed, except for Pioneer Tract when implemented as a mine extension, and the projected flows on average increase by 10 percent, with an increase of 9 percent in the dry season and an increase of 12 percent in the wet season when compared to 2009 flows.

TABLE 84

Projected Contributions to the Upper Charlotte Harbor Estuary and Percent Change from 2009 Flows during Average Rainfall Year and 100 Percent Capture with All Current and Foreseeable Actions within the Peace River Watershed

	Annual Average Flow (cfs)	Annual Average Percent Change from 2009 Flows	Dry Season Average Flow (cfs)	Dry Season Average Percent Change from 2009 Flows	Wet Season Average Flow (cfs)	Wet Season Average Percent Change from 2009 Flows
2009	1,119	0%	510	0%	2,631	0%
2020	1,144	2%	520	2%	2,705	3%
2030	1,137	2%	515	1%	2,700	3%
2040	1,167	4%	528	4%	2,777	6%
2050	1,203	8%	545	7%	2,860	9%
2060	1,232	10%	557	9%	2,925	11%

Table 85 presents the Peace River contributions to the upper Charlotte Harbor Estuary and percent change from 2009 seasonal and annual average flows for the 50 percent capture of stormwater from the mining capture areas under average rainfall conditions. The maximum influence was predicted to occur between 2030 and 2040 according to the capture analysis. Annual average flow increases by approximately 3 to 6 percent during the period of 2030 and 2040, dry season flow increases by approximately 2 to 5 percent, and wet season flow increases by approximately 4 to 7 percent from 2009 levels. Even when considering the three current actions and two foreseeable actions within the Peace River watershed, projected land use changes in this watershed result in increases in flow. By 2060 the projected flows on average increase by 11 percent, with an increase of 10 percent in the dry season and an increase of 12 percent in the wet season when compared to 2009 flows, with results similar to the 100 percent capture case.

TABLE 85

Projected Contributions to the Upper Charlotte Harbor Estuary and Percent Change from 2009 Flows during Average Rainfall Year and 50 Percent Capture with All Current and Foreseeable Actions within the Peace River Watershed

	Annual Average Flow (cfs)	Annual Average Percent Change from 2009 Flows	Dry Season Average Flow (cfs)	Dry Season Average Percent Change from 2009 Flows	Wet Season Average Flow (cfs)	Wet Season Average Percent Change from 2009 Flows
2009	1,119	0%	510	0%	2,631	0%
2020	1,144	2%	520	2%	2,707	3%
2030	1,153	3%	523	2%	2,738	4%
2040	1,182	6%	535	5%	2,806	7%
2050	1,214	9%	550	8%	2,883	10%
2060	1,238	11%	561	10%	2,940	12%

The same evaluation was performed for a low rainfall year (43 inches per year). Table 86 presents the flow and percent change from 2009 average annual and seasonal flows during a low rainfall year with 100 percent capture of stormwater in the capture area of the three current actions and two foreseeable actions within the Peace River watershed. The maximum influence was predicted to occur between 2030 and 2040 according to the capture analysis. Similar to the average rainfall scenarios, based on land use changes within the subwatershed and upstream subwatersheds, annual average flow increases by approximately between 2 and 5 percent during the period of 2030 and 2040, dry season flow increases by approximately between 2 and 4 percent, and wet season flow increases by approximately between 3 and 6 percent from 2009 levels. By 2060 the projected annual average flow increases by 11 percent, with an increase of 10 percent in the dry season and an increase of 12 percent in the wet season when compared to 2009 flows. Similar to the average rainfall analysis, the total footprints of the three current actions and two foreseeable actions encompass a small percentage of the total drainage area for Charlotte Harbor, so the changes in projected land use have a far larger effect on flow than mining.

TABLE 86

Projected Contributions to the Upper Charlotte Harbor Estuary and Percent Change from 2009 Flows during Low Rainfall Year and 100 Percent Capture with All Current and Foreseeable Actions within the Peace River Watershed

	Annual Average Flow (cfs)	Annual Average Percent Change from 2009 Flows	Dry Season Average Flow (cfs)	Dry Season Average Percent Change from 2009 Flows	Wet Season Average Flow (cfs)	Wet Season Average Percent Change from 2009 Flows
2009	568	0%	259	0%	1,338	0%
2020	582	2%	264	2%	1,377	3%
2030	580	2%	263	2%	1,378	3%
2040	596	5%	270	4%	1,418	6%
2050	615	8%	279	8%	1,462	9%
2060	630	11%	285	10%	1,496	12%

Table 87 presents the flow and percent change from 2009 average annual and seasonal flows during a low rainfall year with 50 percent capture of stormwater in the capture area of the three current actions and two foreseeable actions within the Peace River watershed. The maximum influence was predicted to occur between 2030 and 2040 according to the capture analysis and flow results. Similar to the average rainfall scenarios, based on land use changes within the subwatershed and upstream subwatersheds, annual average flow increases by approximately between 4 to 6 percent during the period of 2030 and 2040, dry season flow increases by approximately between 3 to 6 percent, and wet season flow increases by approximately between 4 to 7 percent from 2009 levels. By 2060 the projected annual average flow increases by 12 percent, with an increase of 11 percent in the dry season and an increase of 12 percent in the wet season. Similar to the average rainfall analysis, the changes in land use have a far larger effect on flow than mining.

TABLE 87

Projected Contributions to the Upper Charlotte Harbor Estuary and Percent Change from 2009 Flows during Low Rainfall Year and 50 Percent Capture with All Current and Foreseeable Actions within the Peace River Watershed

	Annual Average Flow (cfs)	Annual Average Percent Change from 2009 Flows	Dry Season Average Flow (cfs)	Dry Season Average Percent Change from 2009 Flows	Wet Season Average Flow (cfs)	Wet Season Average Percent Change from 2009 Flows
2009	568	0%	259	0%	1,338	0%
2020	582	3%	264	2%	1,378	3%
2030	588	4%	266	3%	1,396	4%
2040	603	6%	273	6%	1,432	7%
2050	620	9%	281	9%	1,473	10%
2060	633	12%	287	11%	1,504	12%

To illustrate the effect on the upper Charlotte Harbor Estuary contributions from the Peace River under the conditions and scenarios evaluated, the results are presented graphically and compared to the No Action Alternative conditions. Figures 98 and 99 present the dry season, wet season and annual average flows calculated for the Peace River with and without the three current actions and two foreseeable actions in operation for the 100 percent capture and the 50 percent capture cases, respectively, under average rainfall conditions.

The largest influence on annual average flow from the Peace River watershed during average rainfall conditions were predicted between 2030 and 2040 based on the capture analyses. Based on 100 percent capture of stormwater, the estimated Peace River contributions to the upper Charlotte Harbor may have an average annual flow of approximately 1,168 to 1,195 cfs without mining, and approximately 1,137 to 1,167 cfs with mining between 2030 and 2040. Assuming a 50 percent capture of stormwater, the Peace River watershed may have an average annual flow of approximately 1,153 to 1,182 cfs. This represents a decrease in flow of about 13 cfs when compared to the No Action Alternative conditions.

Figures 100 and 101 present the seasonal and annual average flows calculated for the Peace River contributions to the upper Charlotte Harbor Estuary with and without the three current actions and two foreseeable actions based on 100 percent capture and 50 percent capture of stormwater respectively during low rainfall conditions.

FIGURE 98

Peace River Contributions to Upper Charlotte Harbor Estuary Annual Average and Seasonal Projected Flows for Average Annual Rainfall based on 100 Percent Capture of Excess Rainfall with and without All Current and Foreseeable Actions

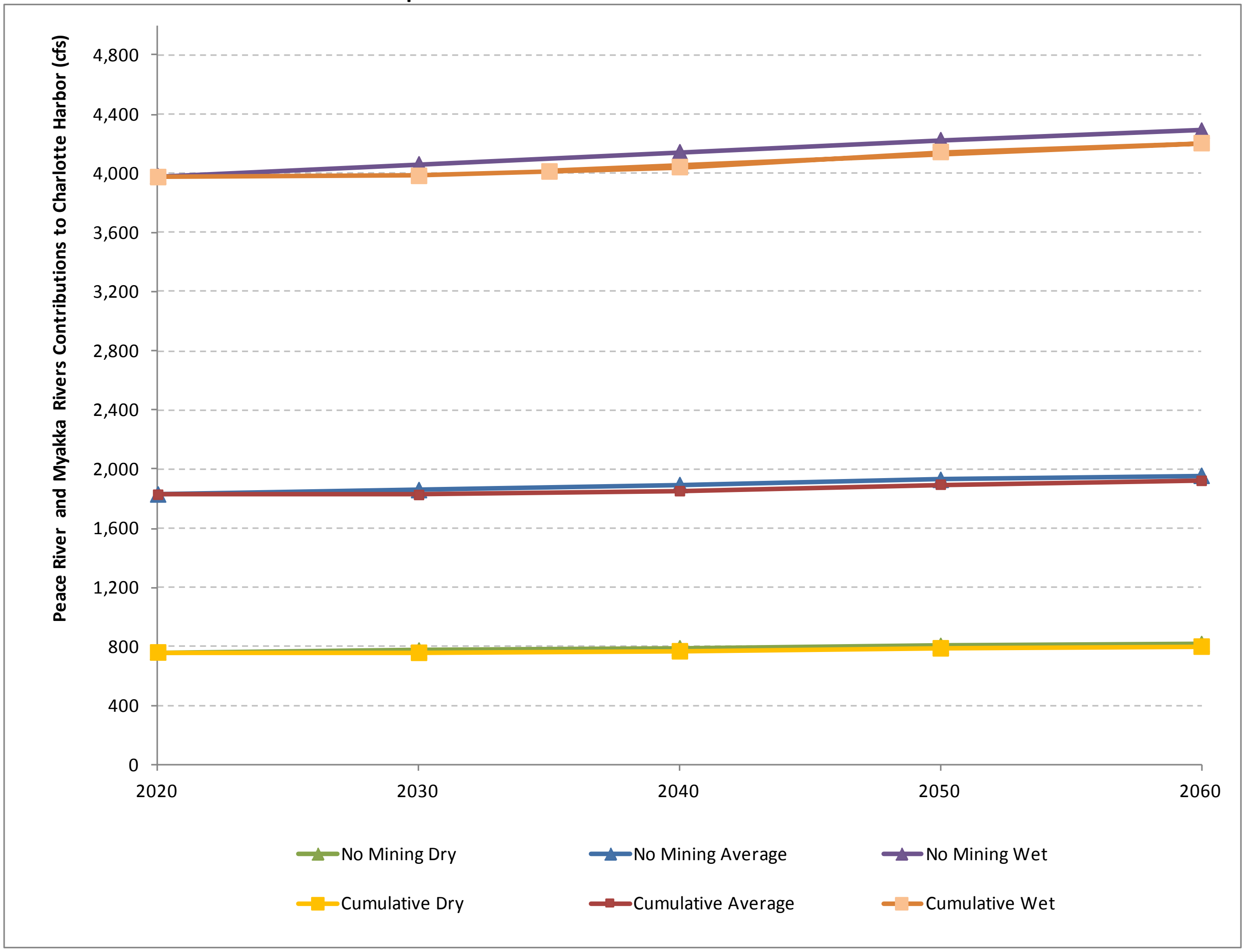


FIGURE 99

Peace River Contributions to Upper Charlotte Harbor Estuary Annual Average and Seasonal Projected Flows for Average Annual Rainfall based on 50 Percent Capture of Excess Rainfall with and without All Current and Foreseeable Actions

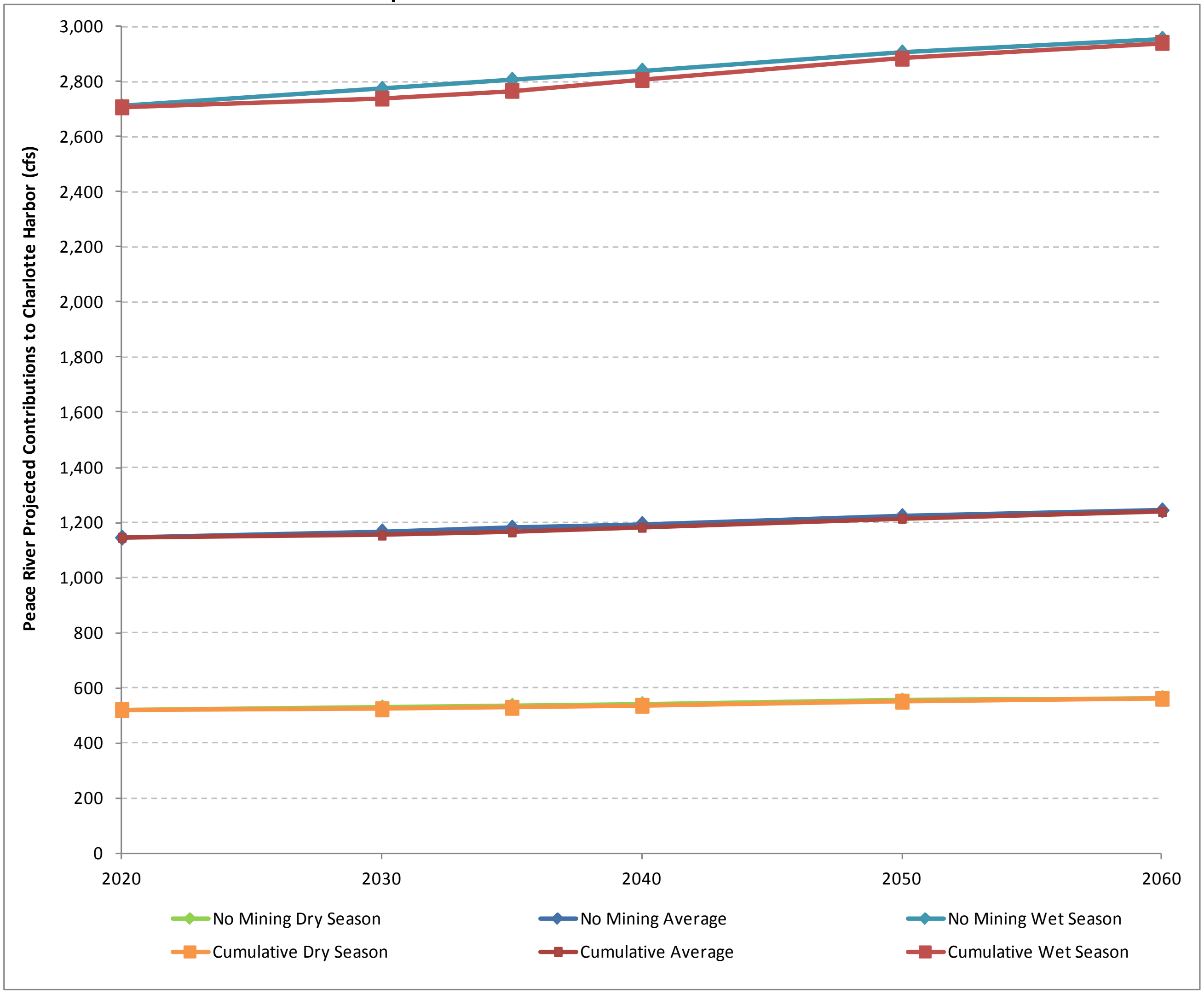


FIGURE 100

Peace River Contributions to Upper Charlotte Harbor Estuary Annual Average and Seasonal Projected Flows for Low Annual Rainfall based on 100 Percent Capture of Excess Rainfall with and without All Current and Foreseeable Actions

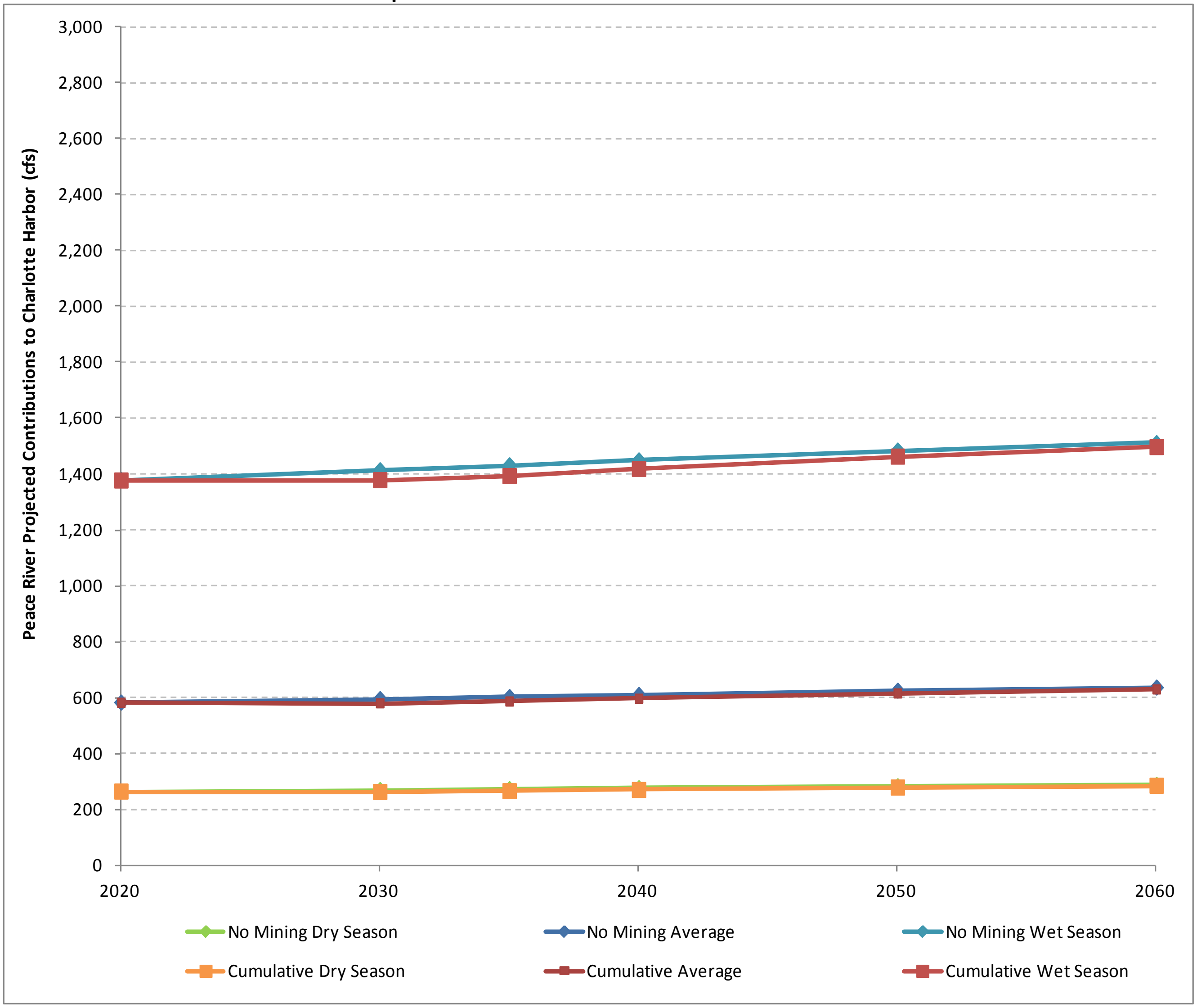
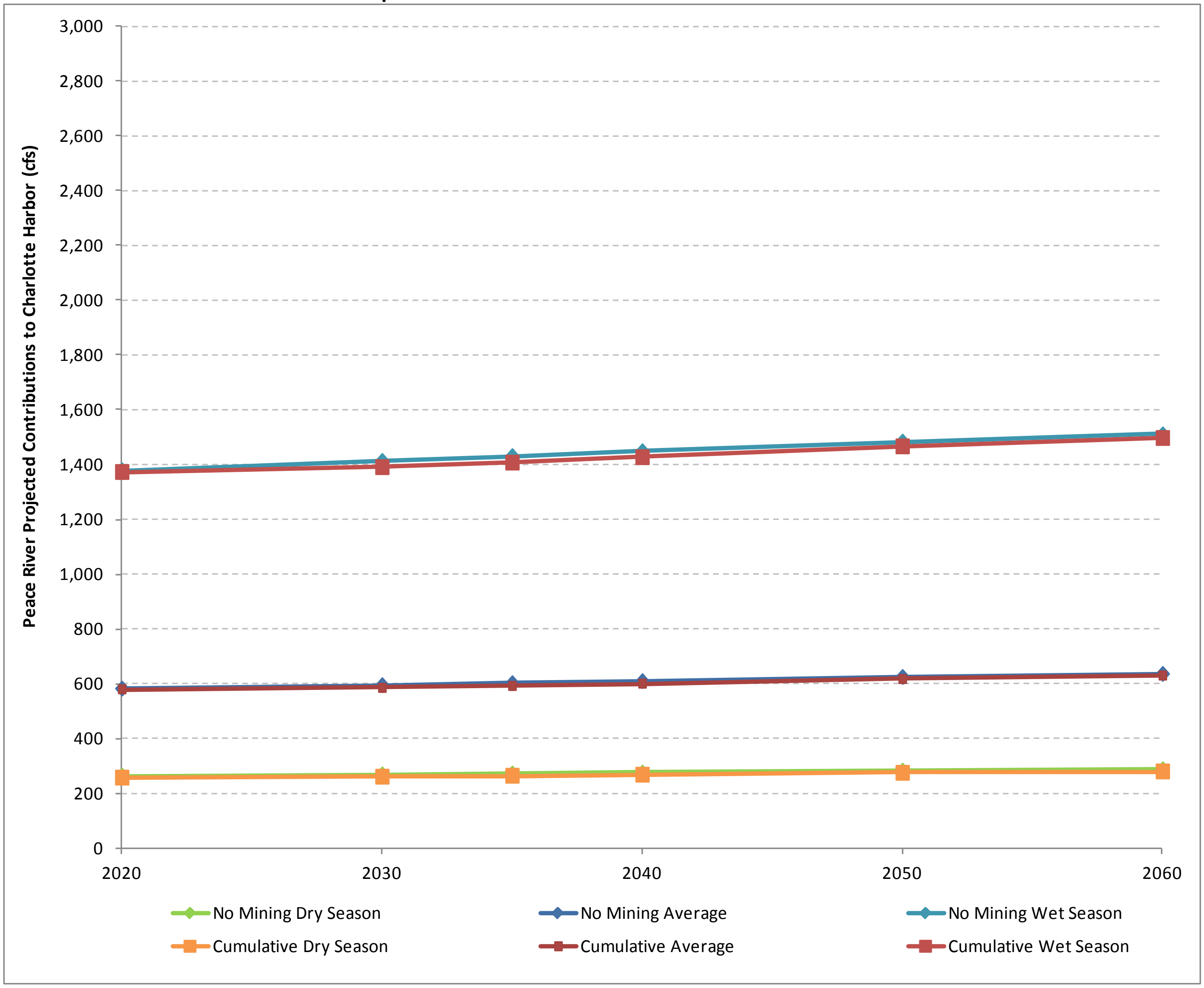


FIGURE 101

Peace River Contributions to Upper Charlotte Harbor Estuary Annual Average and Seasonal Projected Flows for Low Annual Rainfall based on 50 Percent Capture of Excess Rainfall with and without All Current and Foreseeable Actions



The largest influence on annual average flow from the Peace River watershed included in the estimate during low rainfall conditions were predicted between 2030 and 2040 based on the mine capture analyses. Based on 100 percent capture of stormwater, Peace River may have an average annual flow of approximately between 595 to 610 cfs without mining, and approximately 580 to 596 cfs with mining between 2030 and 2040. Assuming a 50 percent capture of stormwater, Peace River contributions to the upper Charlotte Harbor may have an average annual flow of approximately 588 to 603 cfs. This represents a decrease in flow of 7 cfs when compared to the No Action Alternative conditions. The MFL for the lower Peace River near the entrance to Charlotte Harbor is 130 cfs (based on monitored flows at Horse Creek, Peace River at Arcadia, and Shell Creek), which is lower than the predicted flow at the lowest 20th percentile annual rainfall. The three current actions and two foreseeable actions in this subwatershed have minor impact and are not expected to reduce flow by a level that could be easily detected when summed at the three USGS gages. This issue is examined further below in the context of water supply.

5.9.3.2 Myakka River Contributions to Upper Charlotte Harbor Cumulative Impact

Table 88 presents the Myakka River watershed (i.e., those areas in the computations) contributions to the upper Charlotte Harbor Estuary and percent change from 2009 seasonal and annual average flows for the 100 percent capture of stormwater from the mining capture areas under average rainfall conditions (53 inches per year). The maximum influence was predicted to occur around 2055 according to the capture analysis, so an extra analysis was done for this year. Annual average flow increases by approximately 2 percent by 2055, dry season flow increases by approximately 3 percent, and wet season flow increases by approximately 2 percent from 2009 levels. Even when considering the one current action (Wingate East) and one reasonably foreseeable action (Pine Level/Keys Tract) within the Myakka River watershed, projected land use changes in this watershed result in increases in flow. By 2060 the Wingate East Extension would be reclaimed and only Pine Level/Keys Tract implemented as a mine extension would be in operation. The projected flows by 2060 on average increase by 3 percent, with an increase of 4 percent in the dry season, and an increase of 3 percent in the wet season when compared to 2009 flows.

TABLE 88

Projected Contributions to the Upper Charlotte Harbor Estuary and Percent Change from 2009 Flows during Average Rainfall Year and 100 Percent Capture with All Current and Foreseeable Actions within the Myakka River Watershed

	Annual Average Flow (cfs)	Annual Average Percent Change from 2009 Flows	Dry Season Average Flow (cfs)	Dry Season Percent Change from 2009 Flows	Wet Season Average Flow (cfs)	Wet Season Percent Change from 2009 Flows
2009	675	0%	237	0%	1,253	0%
2020	683	1%	240	2%	1,270	1%
2030	689	2%	243	3%	1,284	2%
2040	684	1%	240	1%	1,265	1%
2050	692	2%	244	3%	1,285	3%
2055	691	2%	243	3%	1,280	2%
2060	697	3%	246	4%	1,294	3%

Table 89 presents the Myakka River watershed contributions to the Charlotte Harbor Estuary and percent change from 2009 seasonal and annual average flows for the 50 percent capture of stormwater from the mining capture areas under average rainfall conditions. The maximum influence was predicted to occur around 2055 according to the capture analysis. Annual average flow increases by approximately 4 percent by 2055, dry season flow increases by approximately 4 percent, and wet season flow increases by approximately 4 percent from 2009 levels. The projected flows by 2060 on average increase by 4 percent, with an increase of 5 percent in the dry season, and an increase of 5 percent in the wet season when compared to 2009 flows.

The same evaluation was performed for a low rainfall year (43 inches per year). Table 90 presents the flow and percent change from 2009 average annual and seasonal flows during a low rainfall year with 100 percent capture of stormwater in the capture area of the current and foreseeable actions within the Myakka River watershed. The maximum influence was predicted to occur around 2055 according to the capture analysis. Similar to the average rainfall scenarios, based on projected land use changes within the subwatershed and upstream subwatersheds, annual average flow increases by approximately 2 percent by 2055, dry season flow increases by approximately 3 percent, and wet season flow increases by approximately 2 percent from 2009 levels. By 2060, the projected annual average flow increases by 3 percent, with an increase of 4 percent in the dry season and an increase of 3 percent in the wet season when compared to 2009 flows. Similar to the average rainfall analysis, the changes in projected land use have a far larger effect on flow than mining.

TABLE 89

Projected Contributions to the Charlotte Harbor Estuary and Percent Change from 2009 Flows during Average Rainfall Year and 50 Percent Capture with All Current and Foreseeable Actions within the Myakka River Watershed

	Annual Average Flow (cfs)	Annual Average Percent Change from 2009 Flows	Dry Season Average Flow (cfs)	Dry Season Percent Change from 2009 Flows	Wet Season Average Flow (cfs)	Wet Season Percent Change from 2009 Flows
2009	675	0%	237	0%	1,253	0%
2020	683	1%	241	2%	1,271	1%
2030	690	2%	243	3%	1,286	3%
2040	691	2%	244	3%	1,285	3%
2050	698	3%	247	4%	1,302	4%
2055	699	4%	247	4%	1,303	4%
2060	704	4%	250	5%	1,314	5%

TABLE 90

Projected Contributions to the Upper Charlotte Harbor Estuary and Percent Change from 2009 Flows during Low Rainfall Year and 100 Percent Capture with All Current and Foreseeable Actions within the Myakka River Watershed

	Annual Average Flow (cfs)	Annual Average Percent Change from 2009 Flows	Dry Season Average Flow (cfs)	Dry Season Percent Change from 2009 Flows	Wet Season Average Flow (cfs)	Wet Season Percent Change from 2009 Flows
2009	548	0%	192	0%	1,016	0%
2020	554	1%	195	2%	1,031	1%
2030	559	2%	197	3%	1,042	2%
2040	555	1%	195	1%	1,027	1%
2050	561	2%	198	3%	1,042	3%
2055	561	2%	197	3%	1,038	2%
2060	565	3%	199	4%	1,050	3%

Table 91 presents the flow and percent change from 2009 average annual and seasonal flows during a low rainfall year with 50 percent capture of stormwater in the capture area of the current and foreseeable actions within the Myakka River watershed. The maximum influence was predicted to occur around 2055 according to the capture analysis. Similar to the average rainfall scenarios, based on projected land use changes within the subwatershed and upstream subwatersheds, annual average flow increases by approximately 4 percent by 2055, dry and wet season flow also increases by approximately 4 percent from 2009 levels. By 2060 the projected annual average flow increases by 4 percent for annual, and about 5 percent for dry and wet seasons when compared to 2009 flows.

To illustrate the effect on upper Charlotte Harbor Estuary contributions from most of the Myakka River under the conditions and scenarios evaluated, the results are presented graphically and compared to the No Action Alternative conditions. Figures 102 and 103 present the dry season, wet season and annual average flows calculated for the Myakka River with and without the current and foreseeable actions in operation for the 100 percent capture and the 50 percent capture cases, respectively, under average rainfall conditions.

TABLE 91

Projected Contributions to the Upper Charlotte Harbor Estuary and Percent Change from 2009 Flows during Low Rainfall Year and 50 Percent Capture with All Current and Foreseeable Actions within the Myakka River Watershed

	Annual Average Flow (cfs)	Annual Average Percent Change from 2009 Flows	Dry Season Average Flow (cfs)	Dry Season Percent Change from 2009 Flows	Wet Season Average Flow (cfs)	Wet Season Percent Change from 2009 Flows
2009	548	0%	192	0%	1,016	0%
2020	554	1%	195	2%	1,031	1%
2030	560	2%	198	3%	1,043	3%
2040	560	2%	198	3%	1,042	3%
2050	566	3%	200	4%	1,056	4%
	567	4%	201	4%	1,057	4%
2060	571	4%	202	5%	1,066	5%

FIGURE 102

Myakka River Contributions to Upper Charlotte Harbor Estuary Annual Average and Seasonal Projected Flows for Average Annual Rainfall based on 100 Percent Capture of Excess Rainfall with and without All Current and Foreseeable Actions

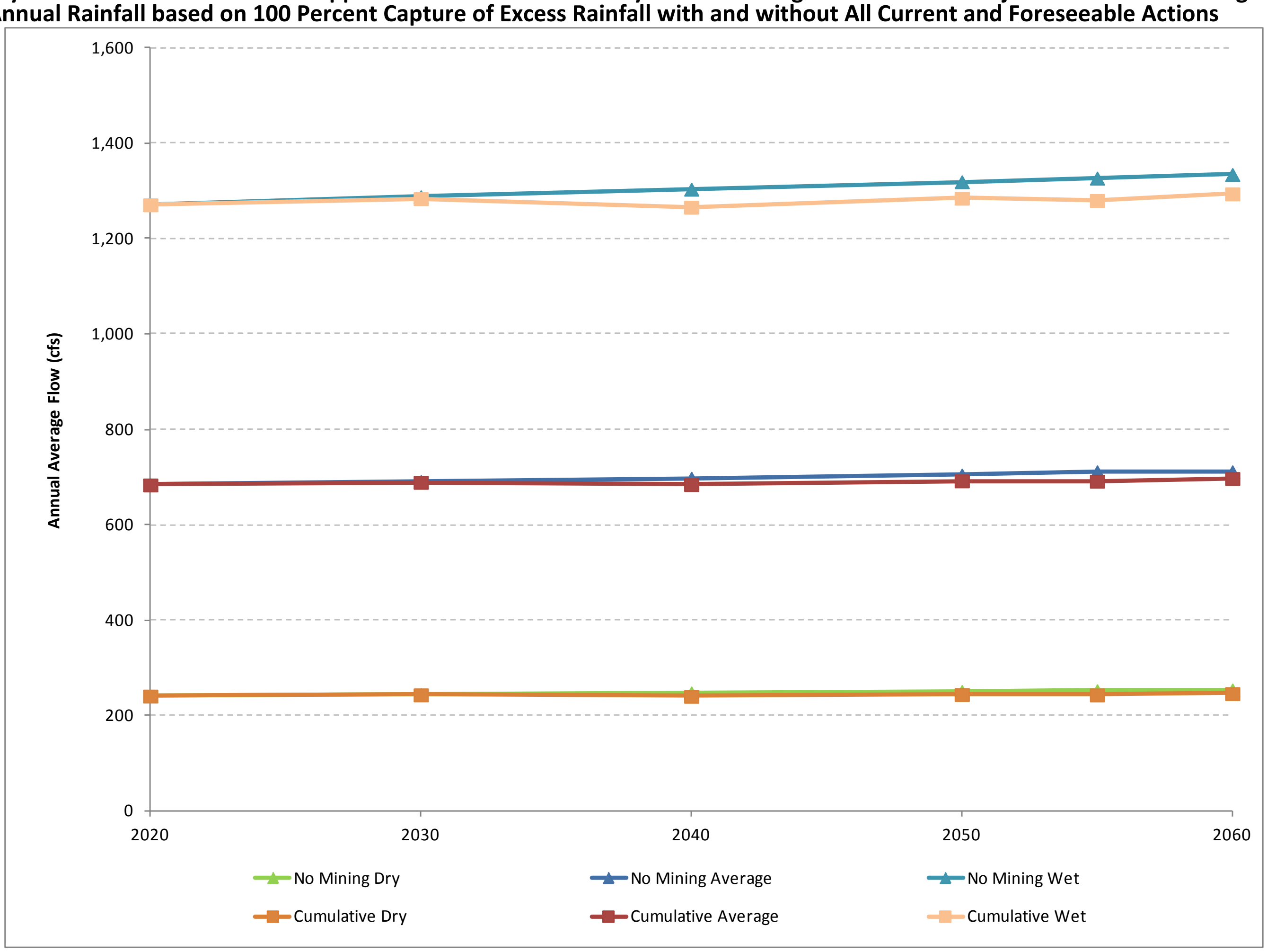
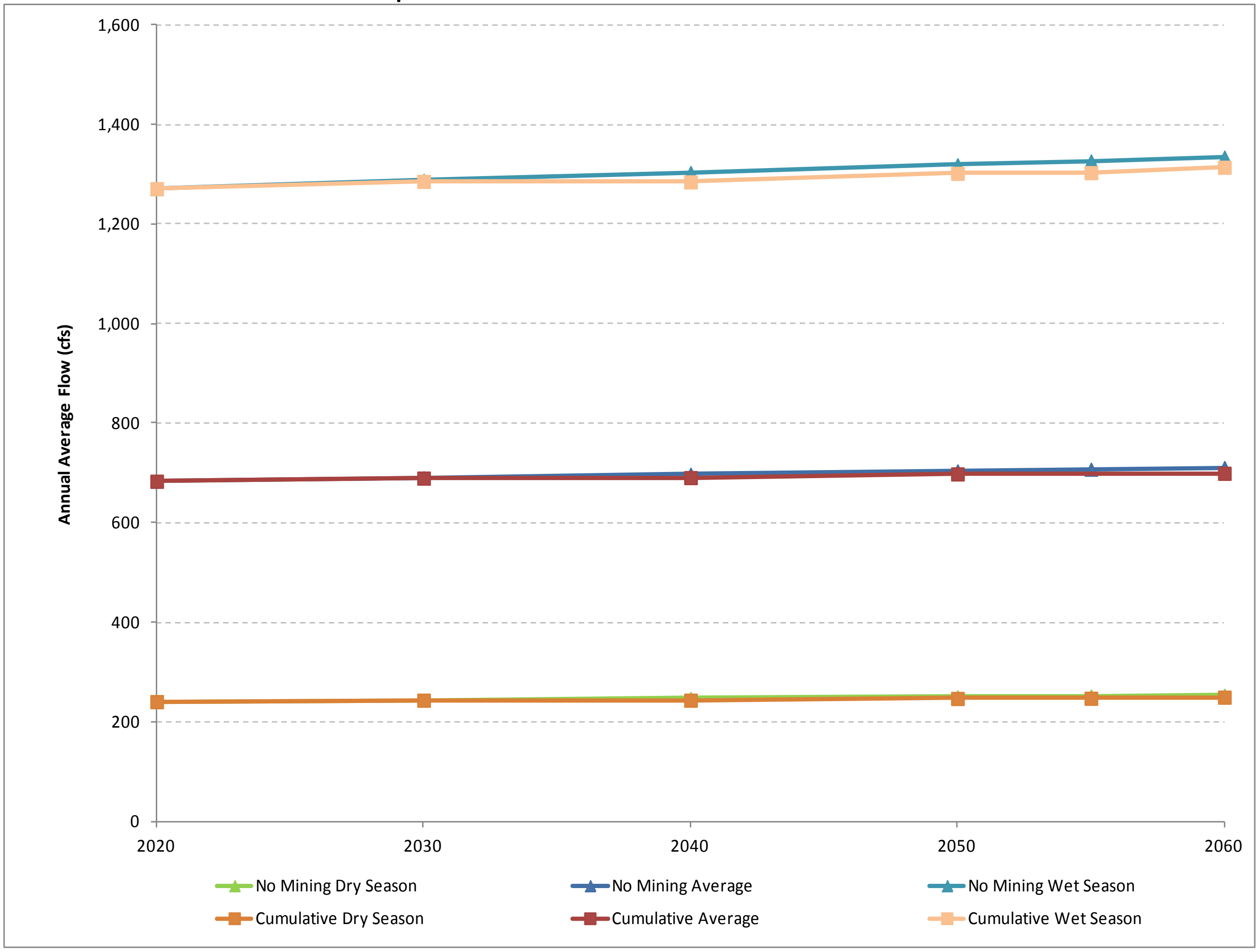


FIGURE 103

Myakka River Contributions to Upper Charlotte Harbor Estuary Annual Average and Seasonal Projected Flows for Average Annual Rainfall based on 50 Percent Capture of Excess Rainfall with and without All Current and Foreseeable Actions



The largest influence on annual average flow from the Myakka River watershed during average rainfall conditions were predicted around 2055 based on the capture analyses. Based on 100 percent capture of stormwater Myakka River contributions (from the area included) to the upper Charlotte Harbor may have an average annual flow of approximately 711 cfs without mining, and approximately 691 cfs with mining by 2055. Assuming a 50 percent capture of stormwater, the Myakka River may have an average annual flow of approximately 699 cfs. This means a reduction in flow of approximately 12 cfs when compared to the No Action Alternative conditions for average annual rainfall.

Figures 104 and 105 present the seasonal and annual average flows calculated for most of the Myakka River contributions to the upper Charlotte Harbor Estuary with and without the current and foreseeable actions based on 100 percent capture and 50 percent capture of stormwater respectively during low rainfall conditions.

FIGURE 104

Myakka River Contributions to Upper Charlotte Harbor Estuary Annual Average and Seasonal Projected Flows for Low Annual Rainfall based on 100 Percent Capture of Excess Rainfall with and without All Current and Foreseeable Actions

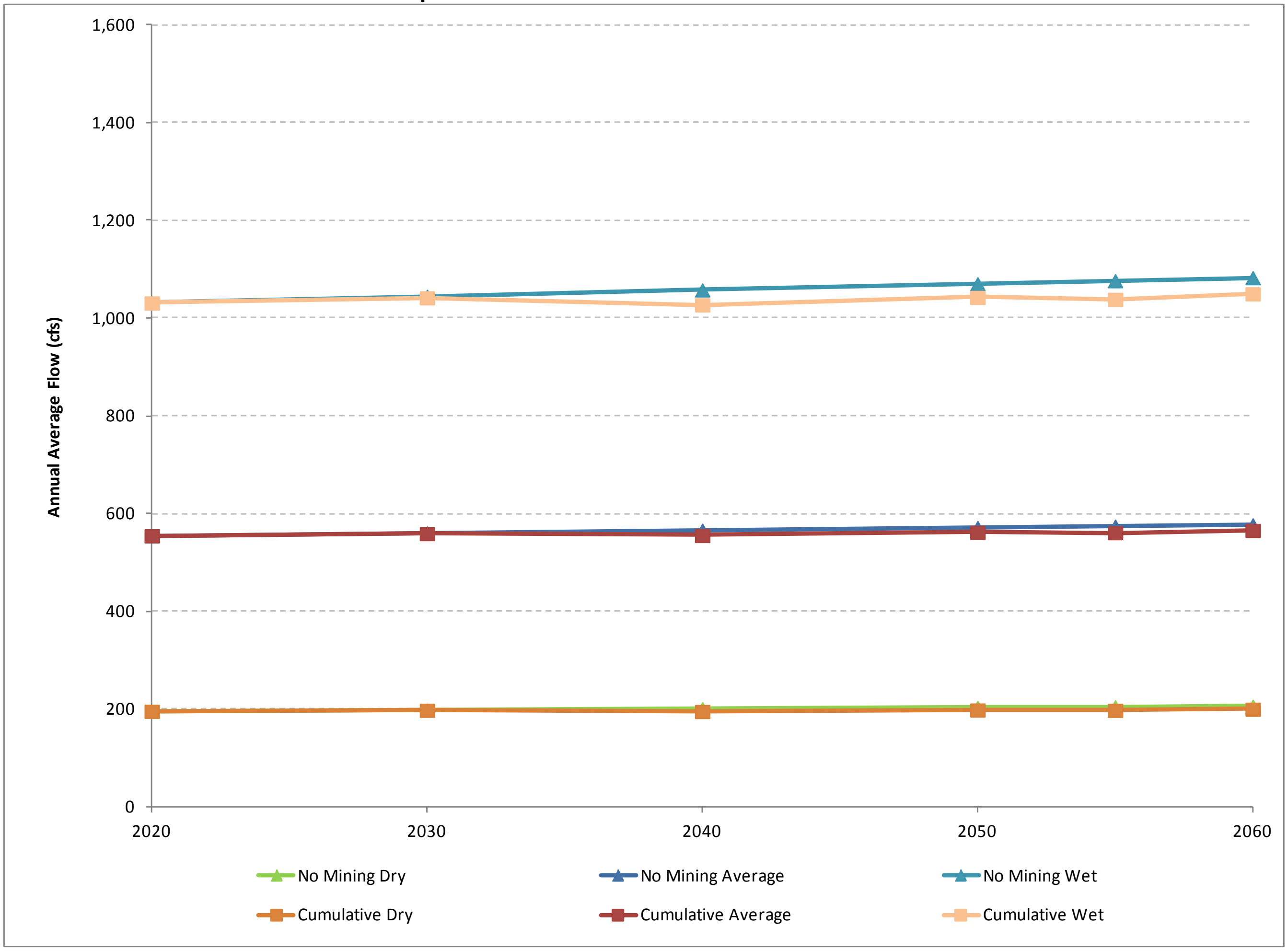
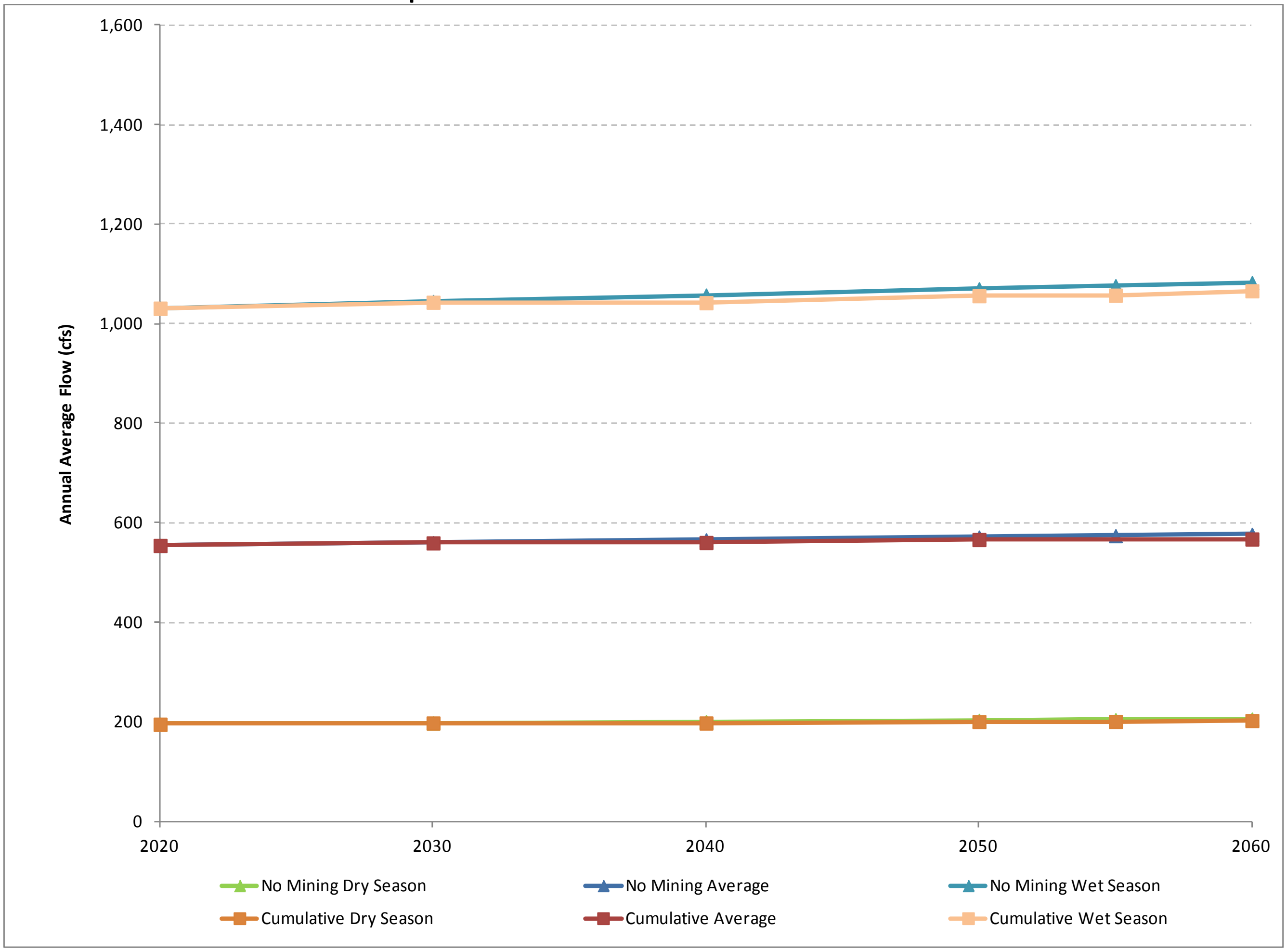


FIGURE 105

Myakka River Contributions to Upper Charlotte Harbor Estuary Annual Average and Seasonal Projected Flows for Low Annual Rainfall based on 50 Percent Capture of Excess Rainfall with and without All Current and Foreseeable Actions



The largest influence on annual average flow from the Myakka River watershed during low rainfall conditions were predicted around 2055 based on the mine capture analyses. Based on either the 100 or 50 percent capture of stormwater, the Myakka River may have an average annual flow of approximately between 574 cfs without mining, and approximately 561 cfs with mining by 2055. Assuming a 50 percent capture of stormwater, the Myakka River may have an average annual flow of approximately 567 cfs. This represents a decrease in flow of about 7 cfs when compared to the No Action Alternative conditions for low rainfall. MFLs have been established in the Myakka River watershed for only portions of the watershed and since the predicted flows are from multiple streams flowing directly into Charlotte Harbor, no direct comparison can be made.

5.9.3.3 Myakka and Peace River Combined Contributions to Upper Charlotte Harbor Cumulative Impact

Table 92 presents the total of the Myakka and Peace River contributions estimated (that is, most of these watersheds' area) to the upper Charlotte Harbor Estuary and percent change from 2009 seasonal and annual average flows for the 100 percent capture of stormwater from the mining capture areas under average rainfall conditions. The maximum influence was predicted to occur between 2030 and 2050 according to the capture analysis. Annual average flow increases by approximately between 2 to 6 percent during the period of 2030 and 2050, dry season flow increases by approximately between 2 to 5 percent, and wet season flow increases by approximately between 3 to 7 percent when compared to 2009 levels. Even when considering the four current actions and two reasonably foreseeable actions within the Myakka and Peace River watersheds, projected land use changes in these watersheds result in increases in flow. By 2060 most mines are reclaimed except for the two foreseeable actions, Pine Level/Keys and Pioneer Tracts, which were evaluated as extensions to existing mines. The projected flows by 2060 on average increase by 7 percent, with an increase of 7 percent in the dry season and an increase of 8 percent in the wet season when compared to 2009 flows.

TABLE 92

Projected Contributions to the Charlotte Harbor Estuary and Percent Change from 2009 Flows during Average Rainfall Year and 100 Percent Capture with All Current and Foreseeable Actions within the Myakka and Peace River Watersheds

	Annual Average Flow (cfs)	Annual Average Percent Change from 2009 Flows	Dry Season Average Flow (cfs)	Dry Season Average Percent Change from 2009 Flows	Wet Season Average Flow (cfs)	Wet Season Average Percent Change from 2009 Flows
2009	1,794	0%	747	0%	3,884	0%
2020	1,827	2%	760	2%	3,976	2%
2030	1,825	2%	758	2%	3,984	3%
2040	1,851	3%	768	3%	4,043	4%
2050	1,895	6%	788	5%	4,145	7%
2060	1,921	7%	800	7%	4,205	8%

Table 93 presents the combined rivers' contributions to the upper Charlotte Harbor Estuary and percent change from 2009 seasonal and annual average flows for the 50 percent capture of stormwater from the mining capture areas under average rainfall conditions. The maximum influence was predicted to occur between 2030 and 2050 according to the capture analysis. Annual average flow increases by approximately between 3 and 7 percent during the period of 2030 and 2050, dry season flow increases by approximately between 3 and 7 percent, and wet season flow increases by approximately between 4 and 8 percent from 2009 levels. Even when considering all four current actions and two reasonably foreseeable actions within the Myakka and Peace River watersheds, projected land use changes in these watersheds result in increases in flow. By 2060 the projected flows on average and during the dry season increase by 8 percent, with an increase of 9 percent in the wet season when compared to 2009 flows.

TABLE 93

Projected Contributions to the Charlotte Harbor Estuary and Percent Change from 2009 Flows during Average Rainfall Year and 50 Percent Capture with All Current and Foreseeable Actions within the Myakka and Peace River Watersheds

	Annual Average Flow (cfs)	Annual Average Percent Change from 2009 Flows	Dry Season Average Flow (cfs)	Dry Season Average Percent Change from 2009 Flows	Wet Season Average Flow (cfs)	Wet Season Average Percent Change from 2009 Flows
2009	1,794	0%	747	0%	3,884	0%
2020	1,828	2%	761	2%	3,978	2%
2030	1,843	3%	766	3%	4,024	4%
2040	1,872	4%	779	4%	4,091	5%
2050	1,912	7%	797	7%	4,185	8%
2060	1,937	8%	808	8%	4,244	9%

The same evaluation was performed for a low rainfall year. Low rainfall conditions were estimated as the 20^{th} percentile of the annual rainfall totals for the period of record (i.e., 80 percent of the years had higher rainfall). For both the Myakka and Peace River watersheds cumulative analysis, this calculation used 43 inches of rainfall per year.

Table 94 presents the flow and percent change from 2009 average annual and seasonal flows during a low rainfall year with 100 percent capture of stormwater in the capture area of the four current actions and two reasonably foreseeable actions within the Myakka and Peace River watersheds. The maximum influence was predicted to occur between 2030 and 2050 according to the capture analysis. Similar to the average rainfall scenarios, based on land use changes within the subwatershed and upstream subwatersheds, annual average flow increases by approximately between 2 to 5 percent during the period of 2030 and 2050, dry season flow increases by approximately between 2 to 6 percent, and wet season flow increases by approximately between 3 to 6 percent from 2009 levels. By 2060 the projected annual average flow increases by 7 percent, with an increase of 7 percent in the dry season and an increase of 8 percent in the wet season when compared to 2009 flows. Similar to the average rainfall analysis, the projected changes in land use have a far larger effect on flow than mining.

TABLE 94

Projected Contributions to the Charlotte Harbor Estuary and Percent Change from 2009 Flows during Low Rainfall Year and 100 Percent Capture with All Current and Foreseeable Actions within the Myakka and Peace River Watersheds

	Annual Average Flow (cfs)	Annual Average Percent Change from 2009 Flows	Dry Season Average Flow (cfs)	Dry Season Average Percent Change from 2009 Flows	Wet Season Average Flow (cfs)	Wet Season Average Percent Change from 2009 Flows
2009	1,116	0%	451	0%	2,354	0%
2020	1,136	2%	459	2%	2,408	2%
2030	1,139	2%	460	2%	2,420	3%
2040	1,151	3%	465	3%	2,446	4%
2050	1,177	5%	476	6%	2,505	6%
2060	1,190	7%	482	7%	2,535	8%

Table 95 presents the flow and percent change from 2009 average annual and seasonal flows during a low rainfall year with 50 percent capture of stormwater in the capture area of the current actions and two reasonably foreseeable actions within the Peace and Myakka River watersheds. The maximum influence was predicted to occur between 2030 and 2050 according to the capture analysis. Similar to the average rainfall scenarios, based on land use changes within the subwatershed and upstream subwatersheds, annual average flow increases by approximately 3 to 6 percent during the period of 2030 and 2050, dry season flow increases by approximately 3 to 7 percent, and wet season flow increases by approximately 4 to 7 percent from 2009 levels. By 2060 the projected annual average and dry season flow increases by 8 percent, with an increase of 9 percent in the wet season.

TABLE 95

Projected Contributions to the Charlotte Harbor Estuary and Percent Change from 2009 Flows during Low Rainfall Year and 50 Percent Capture with All Current and Foreseeable Actions within the Myakka and Peace River Watersheds

	Annual Average Flow (cfs)	Annual Average Percent Change from 2009 Flows	Dry Season Average Flow (cfs)	Dry Season Average Percent Change from 2009 Flows	Wet Season Average Flow (cfs)	Wet Season Average Percent Change from 2009 Flows
2009	1,116	0%	451	0%	2,354	0%
2020	1,137	2%	460	2%	2,409	2%
2030	1,147	3%	464	3%	2,440	4%
2040	1,164	4%	471	4%	2,475	5%
2050	1,187	6%	482	7%	2,530	7%
2060	1,201	8%	488	8%	2,561	9%

To illustrate the effect on the upper Charlotte Harbor Estuary, contributions from the Myakka and Peace River watersheds included under the conditions and scenarios evaluated, the results are presented graphically and compared to the No Action Alternative conditions. Figures 106 and 107 present the dry season, wet season, and annual average flows calculated for the Myakka and Peace Rivers together with and without the four current actions and two reasonably foreseeable actions in operation for the 100 percent capture and the 50 percent capture cases, respectively, under average rainfall conditions.

The largest influence on annual average flow from the rivers' watersheds during average rainfall conditions were predicted to occur between 2030 and 2050 based on the capture analyses. Based on 100 percent capture of stormwater, most of the area contributions to the upper Charlotte Harbor may have an average annual flow of approximately 1,858 to 1,928 cfs without mining and approximately 1,826 to 1,894 cfs with mining between 2030 and 2050. Assuming a 50 percent capture of stormwater, the Charlotte Harbor Estuary may receive an average annual flow of approximately 1,843 to 1,912 cfs. This means a reduction in flow of approximately 15 to 16 cfs when compared to the No Action Alternative conditions with average rainfall.

Figures 108 and 109 present the seasonal and annual average flows calculated for the Myakka and Peace River contributions to the upper Charlotte Harbor Estuary with and without the four current actions and two reasonably foreseeable actions based on 100 percent capture and 50 percent capture of stormwater, respectively, during low rainfall conditions.

FIGURE 106

Myakka and Peace River Contributions to Upper Charlotte Harbor Estuary Annual Average and Seasonal Projected Flows for Average Annual Rainfall based on 100 Percent Capture of Excess Rainfall with and without All Current and Foreseeable Actions

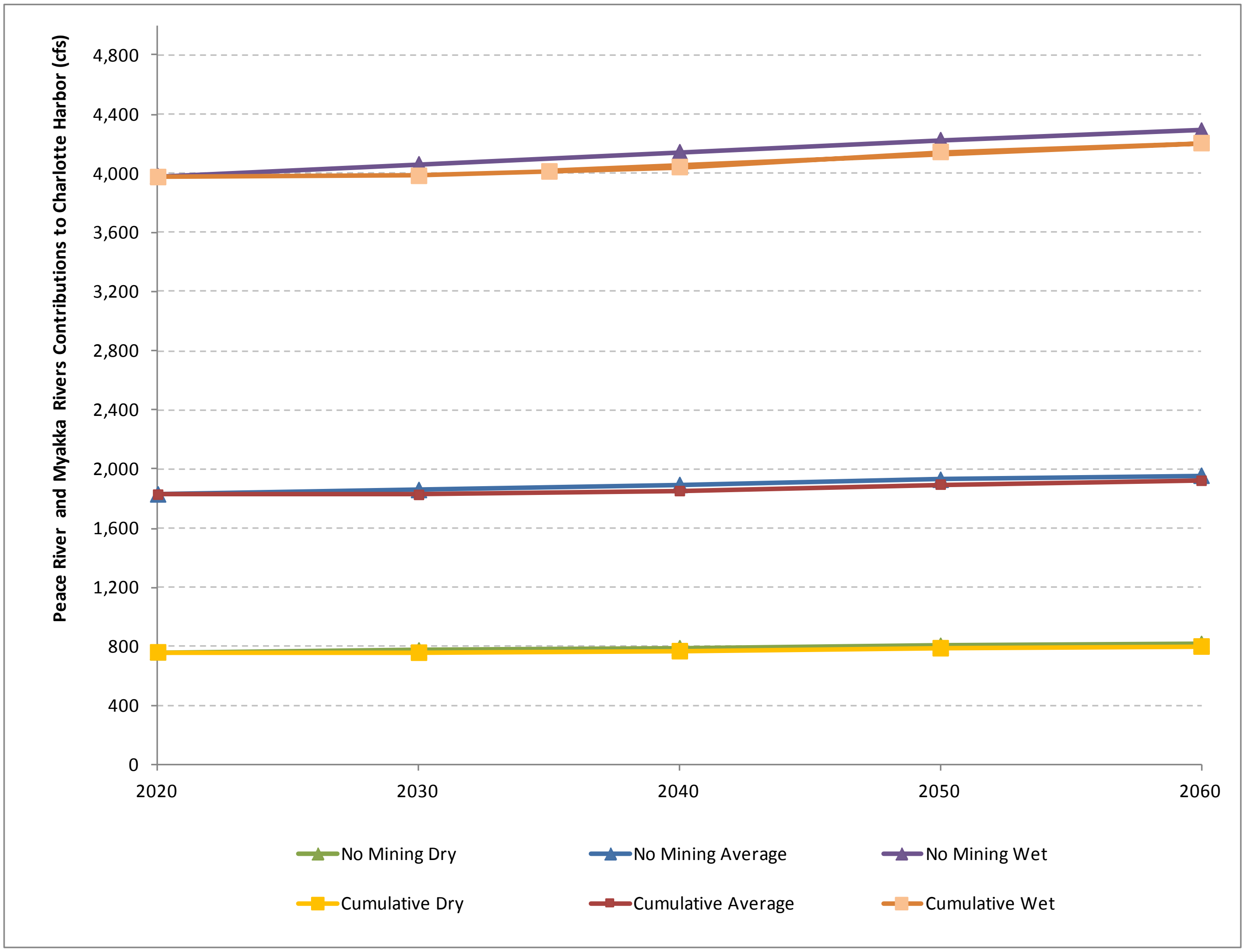


FIGURE 107

Myakka and Peace River Contributions to Charlotte Harbor Estuary Annual Average and Seasonal Projected Flows for Average Annual Rainfall based on 50 Percent Capture of Excess Rainfall with and without All Current and Foreseeable Actions

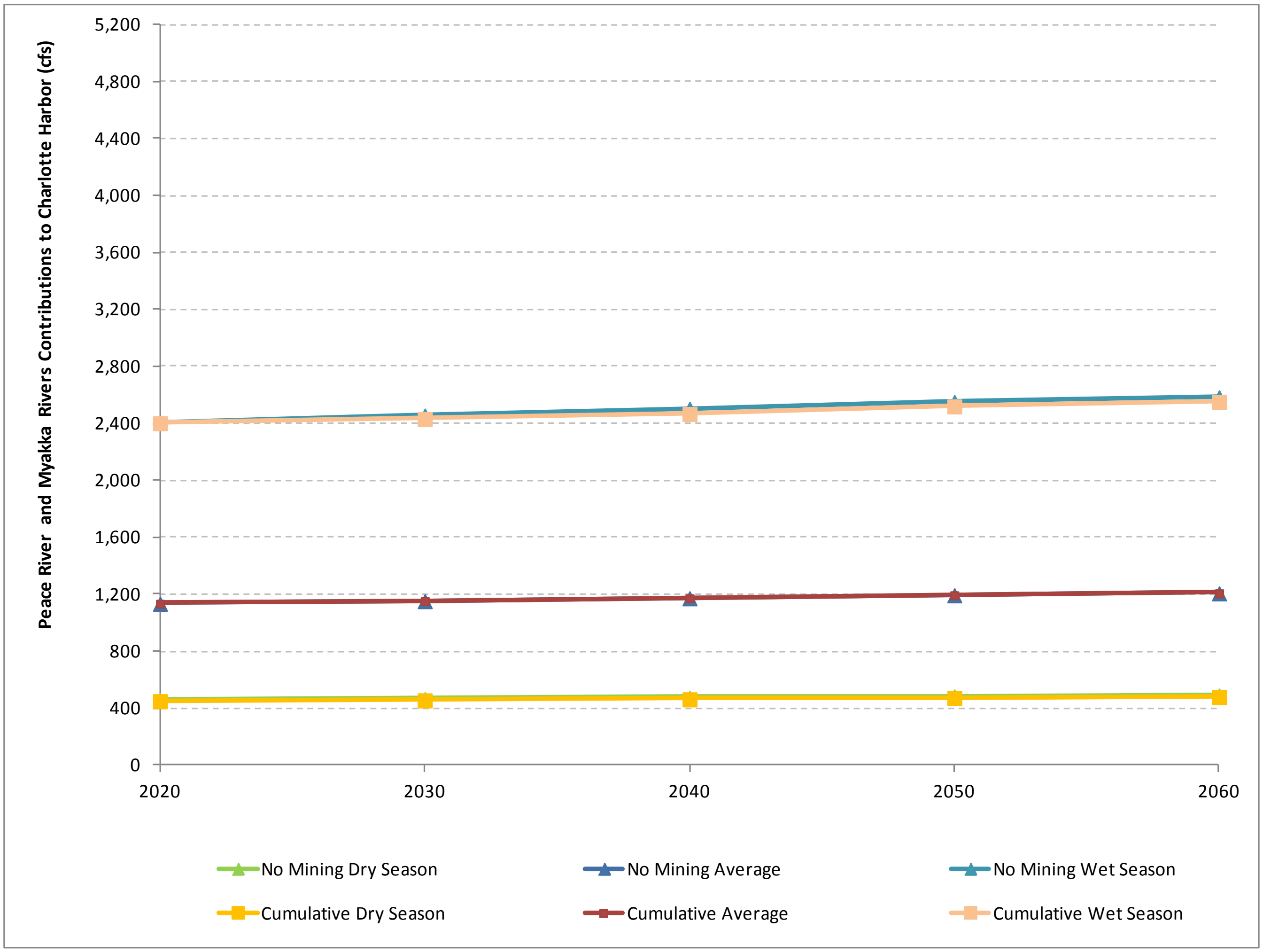


FIGURE 108

Myakka and Peace River Contributions to Charlotte Harbor Estuary Annual Average and Seasonal Projected Flows for Low Annual Rainfall based on 100 Percent Capture of Excess Rainfall with and without All Current and Foreseeable Actions

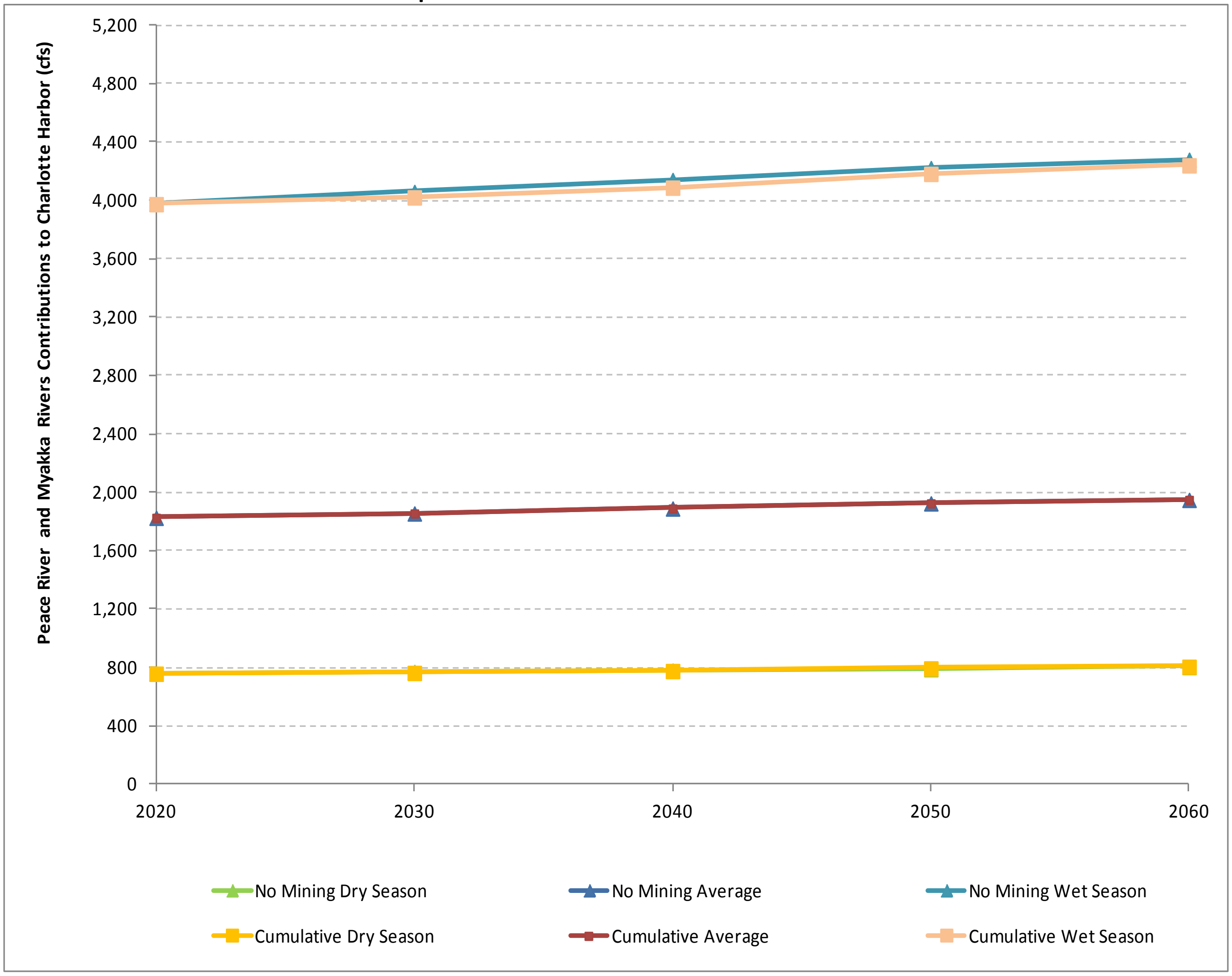
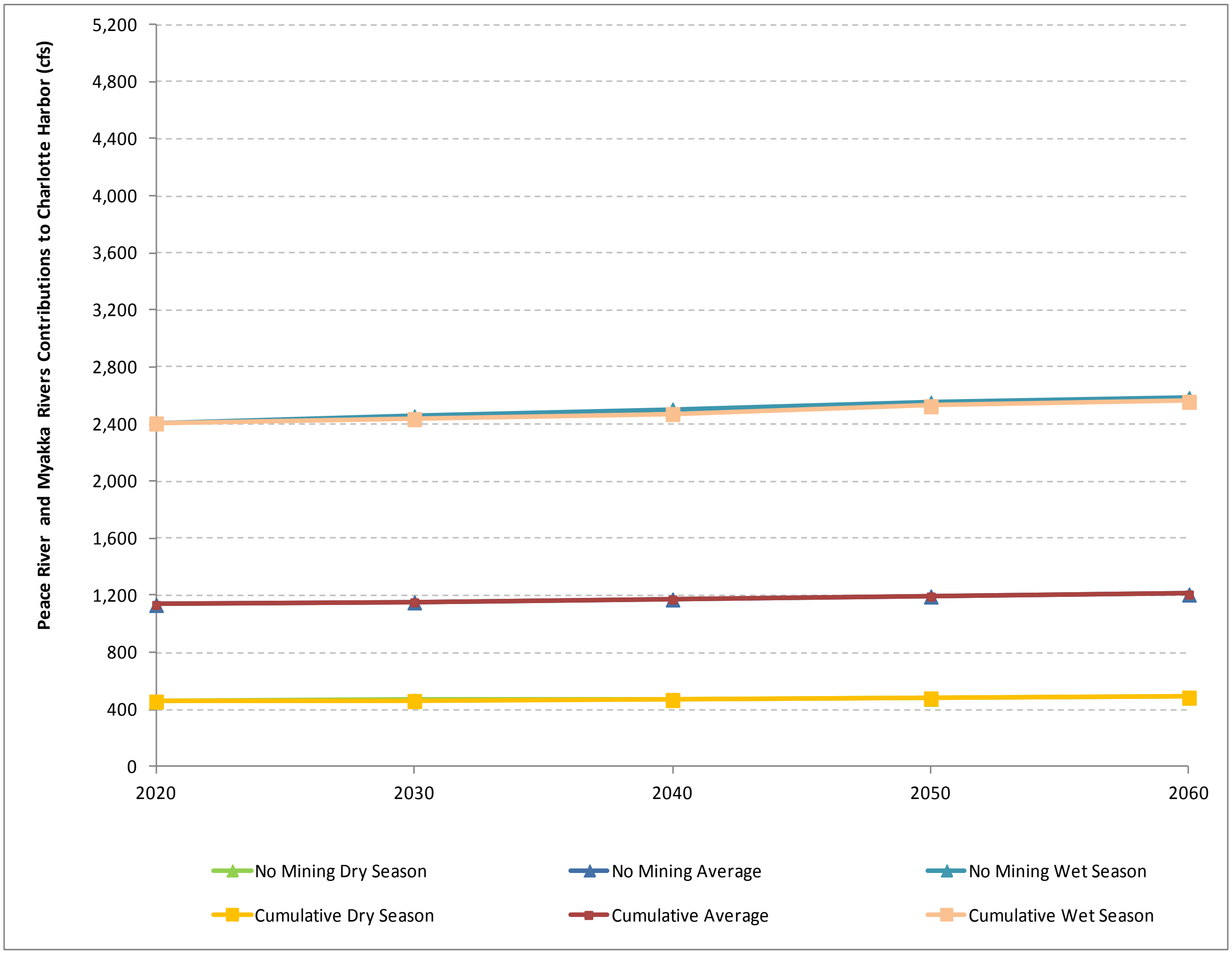


FIGURE 109

Myakka and Peace River Contributions to Charlotte Harbor Estuary Annual Average and Seasonal Projected Flows for Low Annual Rainfall based on 50 Percent Capture of Excess Rainfall with and without All Current and Foreseeable Actions



The largest influence on annual average flow from the rivers' watersheds during low rainfall conditions were predicted to occur between 2030 and 2050 based on the mine capture analyses. Based on 100 percent capture of stormwater, the estimated combined discharge into the upper Charlotte Harbor Estuary may have an average annual flow of approximately 1,155 to 1,196 cfs without mining and approximately 1,139 to 1,177 cfs with mining between 2030 and 2050 under low rainfall conditions. Assuming a 50 percent capture of stormwater, Myakka and Peace River contributions to Charlotte Harbor may have an average annual flow of approximately 1,147 to 1,187 cfs. This represents a decrease in flow of 8 to 11 cfs when compared to the No Action Alternative conditions with low rainfall.

6.0 Low Flow Effects at Surface Water Withdrawal Points

The amount of surface water available for withdrawal is directly linked to Florida's rules that require the water management districts to establish, as needed, MFLs. For creeks and streams, the minimum flow is protective of natural resources where they may be impacted by further water withdrawals that could cause significant harm to the water resources of the area and the related natural environment. As the use of groundwater expanded in southwest-central Florida to a level of concern, the southern and coastal communities started to utilize surface water to supplement their potable water supplies. There are two utilities that use surface water in the two watersheds where the Applicants' Preferred Alternatives or offsite alternatives are located: the Peace River Manasota Regional Water Supply Authority (PRMRWSA) (Peace River) and the City of North Port (Myakka River).

The MFLs studies are important references when evaluating flow rates to an environmentally significant threshold in the two major watersheds. These studies incorporated analysis of allowable withdrawals by the utilities and allowable withdrawals are part of the state rule (Chapter 40D-8,041, Florida Administrative Code). A substantial amount of analysis of the records already conducted in the two watersheds demonstrates that there is great variability between different tributaries and over periods of time. Relatively small changes in flow are difficult to quantify given the variability. SWFWMD establishes desired flow ranges as a percentage of a longer duration flow record. The process used to develop the MFLs and how the utilities operate their facilities (in their permits) is already impacted by continued mining (and other land uses such as agriculture and urbanization) in the watersheds. The effects of future mining from the Applicants need to be evaluated considering how the alternatives will differ from the historical record. This section reviews the MFLs applicable in these watersheds and the potential impact of the four Applicants' Preferred and offsite alternatives on these utilities' surface water supply.

6.1 MFL Review for Surface Water Intakes

The SWFWMD has looked at the water bodies and conducted extensive evaluations to set limitations in the utilities' water use permits. An MFL evaluation can be extensive and requires hydrologic and ecological study of potential effects of withdrawals at various levels. The Peace River has MFLs established at several points in the watershed, but only the limit near the PRMRWSA is discussed below because three Applicants' Preferred and Pioneer Tract Alternatives would be south of the Zolfo Springs gage and there are no other public water supply surface water withdrawals. Similarly, the Myakka River also has MFLs established on it, but not where North Port's intake is in the Big Slough Basin. A brief summary of the flow limits that affect the two utilities is presented here.

The PRMRWSA has a freshwater withdrawal near the downstream end of the Peace River, before the salinity in the estuary influences the water quality to a point that may affect treatment requirements. Their withdrawal is limited to higher flow rates and the utility has an aboveground reservoir and aquifer storage-recovery system (a type of underground reservoir) to extend their supply through dry periods. The proposed MFLs on the lower Peace River have not been codified into rule (SWFWMD MFL website lists latest status). The SWFWMD plans to re-evaluate the MFLs for the lower Peace River by 2015 (SWFWMD, 2010c). The SWFWMD determined from an empirical analysis that a low flow threshold of 130 cfs for the sum of the flows at three USGS gages (Peace River at Arcadia, Joshua Creek at Nocatee, and Horse Creek near Arcadia) will maintain freshwater at the PRMRWSA treatment plant intake location. The MFL report lists the amount of flow that can be withdrawn from the Peace River for water supply (up to a maximum yet to be determined [but up to 400 cfs was evaluated, SWFWMD, 2010c]). The PRMRWSA withdrawal rate is based on a percentage of the previous day's flow and the pumping rate cannot exceed the difference between the sum of the flow less 130 cfs. The percentage of water that can be withdrawn varies during the year as separated into three time blocks, but the 130-cfs low river flow limit does not change. For example, from April 20 through June 25 the PRMRWSA can take 16 percent of the sum of the three gages' flow rates on the next day. So, if there is 175 cfs sum of average daily flow on April 25, then PRMRWSA can withdraw 28 cfs (16% of 175 cfs) on April 26, leaving 147 cfs remaining (i.e., 175 – 28 = 147 cfs). But, if there is a 140-cfs sum of average daily flow on May 1, 16 percent is 22.4 cfs. The utility cannot remove more than 10 cfs on May 2 because that is what is available over 130 cfs (140 – 130 = 10 cfs < 22.4 cfs).

According to the SWFWMD Regional Water Supply Plan (SWFWMD, 2010a), the Peace River at the PRMRWSA plant has available water about 320 days per year, with a range between 152 and 365 days per year. They listed the current permit average annual limit as 32.8 million gallons per day (mgd, 50.7 cfs), but only about 14.9 mgd (23.1 cfs) is being used. The available unpermitted water (to all users) in the Peace River was listed as 80.4 mgd (124.4 cfs), but that could not be actually used unless there is substantial storage because much of that water occurs resulting from short-duration, very wet periods. The PRMRWSA does have substantial storage, but a water supply system needs to look at all components of its system (e.g., intake structure, distribution system) to determine if there is sufficient capacity to meet its needs. Additional storage and other infrastructure would be needed to take advantage of available wet season surface water in excess of the existing permitted limits.

The City of North Port water supply facility is the only permitted public water supply surface water withdrawal in the Myakka River watershed. North Port can withdraw surface water from Myakkahatchee Creek and the

Cocoplum Waterway, but Myakkahatchee Creek is the primary water source (near U.S. 41) with the Cocoplum used only as a back-up source (SWFWMD, 2010b). North Port's facility is linked to the water supply system of the PRMRWSA and the City can receive treated potable water from the PRMRWSA or transfer treated water to it. During times of low flow, the City discontinues withdrawals from Myakkahatchee Creek because of reduced water quality (sulfates) in the creek and receives treated water from the PRMRWSA. The City's permit has a withdrawal limit tied to flow measurements near the intake. There are extensive canals in the urban area that are interconnected and affected by tidal conditions. The historical gage record near North Port is limited; however, the flow measurement devices in this area have been in reliable operation only since 2007.

North Port's withdrawals from Myakkahatchee Creek cannot exceed an annual average rate of 4.4 mgd and a peak month average rate of 6.6 mgd, which are equivalent to flow rates of 6.8 and 10.2 cfs, respectively. The City's 2006 permit required that maximum daily withdrawal rates be linked to the rate of flow in the creek. Daily withdrawals cannot exceed 2.08 mgd (3.2 cfs) when flows at the diversion structure are less than 10 cfs, 4 mgd (6.2 cfs) when flows are between 10 cfs and 30 cfs, and 6 mgd (9.3 cfs) when flows are greater than 30 cfs. There is no MFL on Myakkahatchee Creek because of a lack of historical monitoring data. The SWFWMD plans to revisit the establishment of a MFL when the lower Peace River is re-evaluated in 2015 (SWFWMD, 2010b). For practical purposes, the threshold low flow limit for North Port's intake is 10 cfs. As predicted earlier, the low rainfall year (lowest 20^{th} percentile) estimated average annual flow on the order of 176 cfs with a dry season flow around 100 cfs. The potential impact from a conceptual mine plan for the Pine Level/Keys Tract Alternative was about 5 to 6 cfs, so the flow impacts here are expected to be minor. However, because of the lack of observed data, MFLs, and mine plans, there is higher uncertainty of potential impacts at this location.

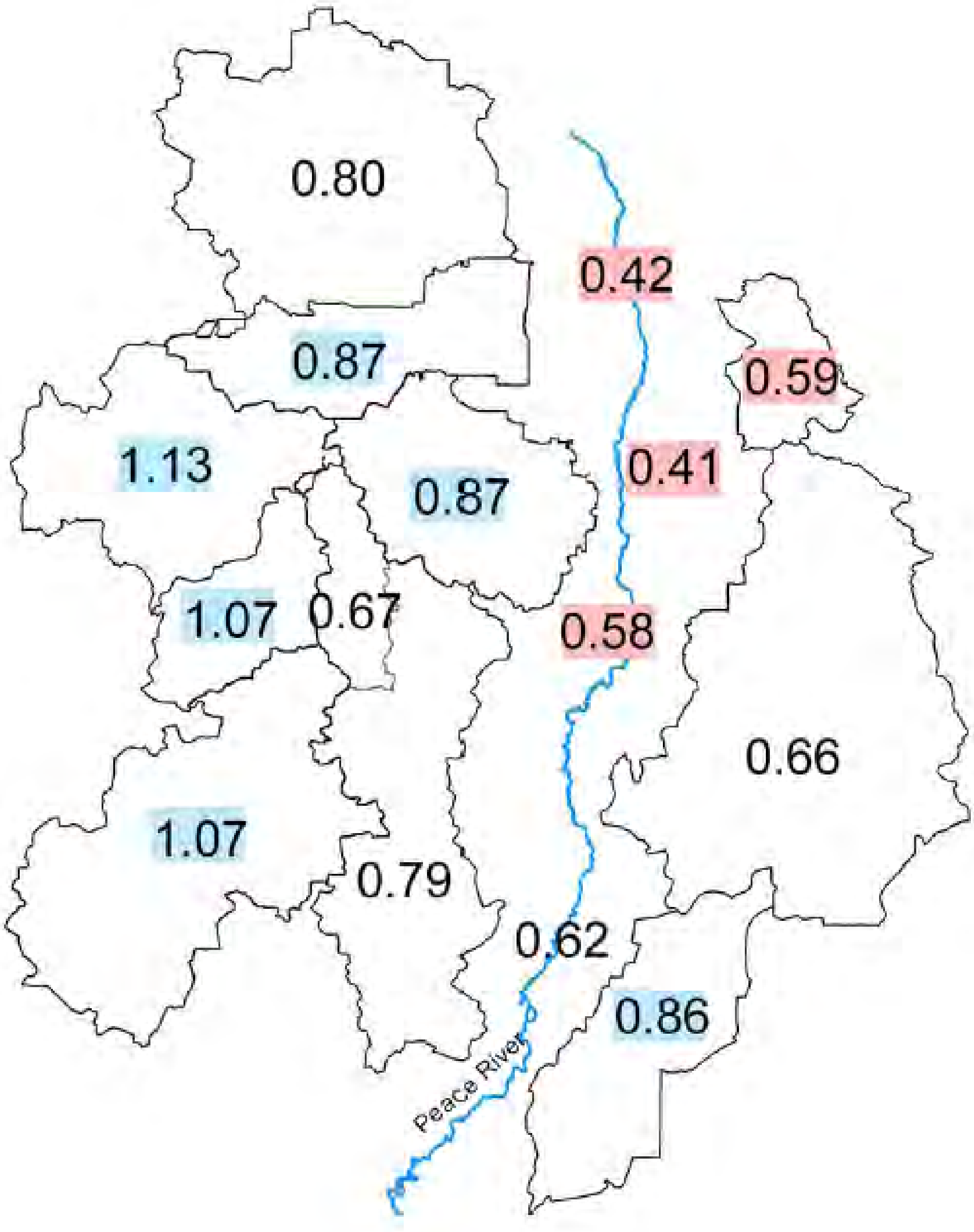
6.2 Variance in Surface Water Delivery from Various Tributaries

While the flow analyses presented above in Section 5 focused on seasonal and annual runoff values, the withdrawals are tied to daily low flows. This section presents an analysis of the low flows based on observed data. The SWFWMD Water Supply Plan (2010a) noted that the variability of available water in the Peace River is high. Depending on the period of record utilized, the hydrologic water balances vary (PBS&J, 2007). While the predicted surface water delivery utilizing runoff coefficients and future land use conditions was useful in evaluating relative trends in annual and seasonal flows, the monitored record of flows is better suited in evaluating the alternatives affect on the daily low flow thresholds.

Historically, most phosphate mining has occurred to the north and is moving toward the southern portions of the CFPD. This is important in this discussion because the amount of surface water delivered (i.e., stormwater runoff, seepage, and groundwater) varies across the watersheds. It is well documented by Metz and Lewelling (2009) and others that flow in the upper Peace River (upstream of the Fort. Meade USGS gage) is affected by karst conditions where portions of streams may drain underground to the upper FAS. Yet further south, these conditions change and the groundwater potentiometric surface (i.e., potential level that confined groundwater in the upper FAS would rise to if unconfined; a measure of pressure) and the ground surface are closer to each other and thus there is a generally higher potential for groundwater discharge (SWFWMD, 2001b). The amount of clay in the soils of the SAS and the thickness of the intermediate FAS also affect how much surface water is delivered from each tributary in the watersheds (Duerr et al., 1988).

Schreuder (2006) analyzed USGS data over 20 years and estimated the unit runoff for the study area, as shown in Figure 110. The low unit streamflow data for the main stem of the Peace River reflects the low yield from the upper Peace River (north of Zolfo Springs). There is a general gradient of low to higher unit streamflow as one moves from the higher topography in the upper Lake Wales region on the east side to the lower elevations on the Coastal Plain to the west and south.

FIGURE 110
Unit Streamflow Derived from Observed Flow Data from 1980 through 2000 in the Central and Southern CFPD
Unit streamflow listed in cfsm



(Source: Schreuder [2006], Figure 24; colors on original figure were not explained.)

A relationship between the interactions of surface water with the underlying aquifer is addressed by the USGS in multiple studies in the Peace River watershed (Lewelling and Wylie, 1993; Lewelling et al., 1998; Metz and Lewelling, 2009; and Lee et al., 2010). The SWFWMD has conducted several comprehensive analyses of the river watersheds in the region, including the Alafia River, Peace River, and upper Myakka River. The Alafia and Peace River studies (SWFWMD, 2005a, and PBS&J, 2007, respectively) led the SWFWMD to conclude that river flows prior to the 1970s were affected by phosphate mine discharges. Schreuder (2006) also noted a distinct change in unit streamflows after the mid-1970s. In general, the change in water use by the phosphate mining industry in the 1970s reduced the industry's reliance on groundwater (by capturing stormwater). Although if one plots flow over time since the 1970s, the flows trend downward, indicating *prima facie* that there was a reduction in surface water delivery (SWFWMD, 2005a). In the Alafia and upper Peace River regions, this reduction is partially a result of the phosphate industry reusing water onsite and eliminating the discharge of the spent groundwater. Once return flows were discounted, reductions in stream flow correlated to the Atlantic Multidecadal Oscillation (AMO) cycle.

The monitored flows in the Myakka River watershed have not decreased over time; however, this is partially a result of limited data and increased agriculture land use. Sources of flows during low flow periods can include groundwater baseflow or other discharges. These other discharges are typically from irrigated agriculture, which has recently become increasing prevalent. Groundwater is pumped for irrigation, especially during droughty periods, and some drainage from the fields is discharged. Therefore, additional review of the monitoring data was conducted for various periods of time.

6.3 Difference in Low Flow Days based on Monitored Daily Data

Several studies have examined average annual flow trends, as discussed above, but fewer literature sources about low flow days are available. These types of discussions utilize probability distributions, where the daily flow is sorted and plotted as a fraction of days over the study period with flows greater than a given value. This can be done using flows (cfs), unit flows (cfsm), or normalized flows (daily flow divided by the average flow). Garlanger (2002) presented a flow chart where the distribution of percent time flow exceeded a given unit flow rate was plotted for various tributaries; the results were similar to those of Schreuder (2006) except the distribution quantifies the range more effectively than averages. In 2011, Garlanger (2011) presented similar plots utilizing the normalized flows to demonstrate changes between time periods. Normalizing the flows accounts for the change resulting from differences in trends, such as the AMO step function (i.e., groups of years with high or low average flows). Garlanger (2011) noted that there has been little change in the Peace River at Arcadia gage data when normalized through 1996 (last year plotted). Mining began in the upper Peace River watershed around 1890, so this time period included both old and new mines with various practices.

The AEIS team reviewed the USGS data for various time periods. The four most relevant gages in the study area are the three of interest in the PRMRWSA withdrawal permit and the upper Myakka River gage (insufficient flow data for North Port). The period of record of these four gages were analyzed, as well as the last 30 years of data broken down into two 15-year periods. Table 96 provides the average, median, and lowest 10th percentile daily flow data for these gages for various time periods. The average can indicate broad-scale trends (e.g., annual), but the median (50 percent of readings higher and lower) and the lowest 10th percentile are better indicators of the magnitude of low daily flows. A lower median flow means that half of the days were lower by comparison. Similarly, for two periods of essentially the same length of time, a lower 10th percentile value means that there were more days with lower flows.

There are differences in results depending on the location of the gage. Starting with the Peace River at Arcadia gage, which has the longest period of record in Table 96, there was a period of high rainfall and flows through the mid-1960s. The data presented for daily flow from 1934 to 1963 demonstrate this in all three metrics (average, median, and 10th percentile). However, the last 30-year record has lower averages, which is expected in the drier period of the 30-year AMO cycle, as documented by others (SWFWMD, 2005a; Kelly, 2004). When the last 30 years are broken into two 15-year periods, the last 15 years (1997 to 2011) have higher average flows, but lower median and much lower 10th percentile flows. To identify the changes in land use that may have contributed to these differences, a plot of the active mining area is shown in Figure 111. This plots shows that the total acreage under active mining decreased after 1996 by about 38 percent. Therefore, the capture of stormwater in current active mines is unlikely to cause lower flow conditions than in the 15 years prior to this, when mining acreages were at their peak. Furthermore, the active mining area is a small fraction of the 2,350-mi^2 Peace River watershed (about 2.66 percent at 40,000 acres of active mining, assuming all is in that watershed).

Further examination of the other gages shows results that differ from the Peace River Arcadia gage. At Horse Creek, the average, mean, and lowest 10th percentile are similar for the period of record (1952 to 2011) and the two 15-year periods between 1982 and 2011. In Joshua Creek, a tributary subwatershed with no mining, the metrics that reflect low flow conditions are much higher in the last 30 years than over the entire period; the most recent 15-year period flow metrics are all higher, even though the average annual values are similar to other periods. The high low flows monitored in Joshua Creek and perhaps Horse Creek could be attributed to an increase in irrigated agriculture (SWFWMD, 2010b; PBS&J, 2007). Since the last 15 years have the lowest rainfall years in the record (see Attachment A) and include significant low flow periods, it stands to reason that drainage from irrigated crops would be high in droughty conditions. For example, in the upper Myakka River, where the irrigation return flow is a documented concern (SWFWMD, 2005b), the 10th percentile flow was much higher in the 1982 to 1996 period but closer to average in the past 15-year period (1997 to 2011). Consequently, the dry conditions may have reduced surface water delivery but increased daily flow supplemented by the irrigation return flows.

Figure 112 illustrates the plots of the four relevant gages' normalized flow (daily flow divided by the average for the given period). In these plots, the low flows have a range of results that demonstrate variability around the period of record line, except for Joshua and Horse Creeks, where the lower flows fall to the right of the line. As demonstrated previously in this TM, there is a broad range of flow rates recorded over time. Upon inspection of the annual rainfall amounts in Attachment A for Polk, Hardee, and DeSoto Counties, the rain has been more variable in the last 15 years than in the 15 years prior to that. However, when the entire record of rainfall is reviewed, there is even more variability in annual precipitation earlier in the record than in the recent period, especially during the higher rainfall years prior to 1970. One standard deviation above and below the mean since 1980 was plotted previously because it contains about 70 percent of the monitoring results since the current groundwater conservation practices went into effect, but that also leaves about 30 percent outside that range so the actual data are more variable than is visibly evident in the predicted flow plots in Section 5. Given the naturally high variability in runoff/daily flow and relatively small footprint of mining when compared to agriculture and urban uses, it is difficult to attribute flow variations to specific mining practices in the whole watersheds when more specific studies of tributaries with and without mining do not support a similar conclusion (Lewelling and Wylie, 1993; Schreuder, 2006; Garlanger, 2002).

TABLE 96
Average, Median, and 10th Percentile Flows at Selected USGS Gages in Area of Interest

USGS Gage	Time Period	Average (cfs)	Median (cfs)	Lowest 10th Percentile (cfs)
Horse Creek Near Arcadia	**1952-2011**	**190**	**45.0**	**3.7**
	1982-1996	179	51.0	5.3
	1997-2011	199	40.0	4.5
Peace River Near Arcadia	**1934-2011**	**1,054**	**449**	**110**
	1934-1963	1,318	578	141
	1982-1996	868	417	112
	1997-2011	943	341	57
Joshua Creek Near Nocatee	**1950-2011**	**109**	**29**	**4.8**
	1950-1963	121	18	1.5
	1982-1996	111	38	11
	1997-2011	121	38	14
Myakka River Near Sarasota	**1970-2011**	**236**	**90**	**6.7**
	1982-1996	251	114	15
	1997-2011	248	82	6.5

FIGURE 111

Approximate Acreage of Mining in the CFPD Study Area: Past (historical and not reclaimed to date), Present (active mines), Applicants' Preferred Alternatives (per applications) and Pine Level/Keys and Pioneer Alternatives (foreseeable, per AEIS)

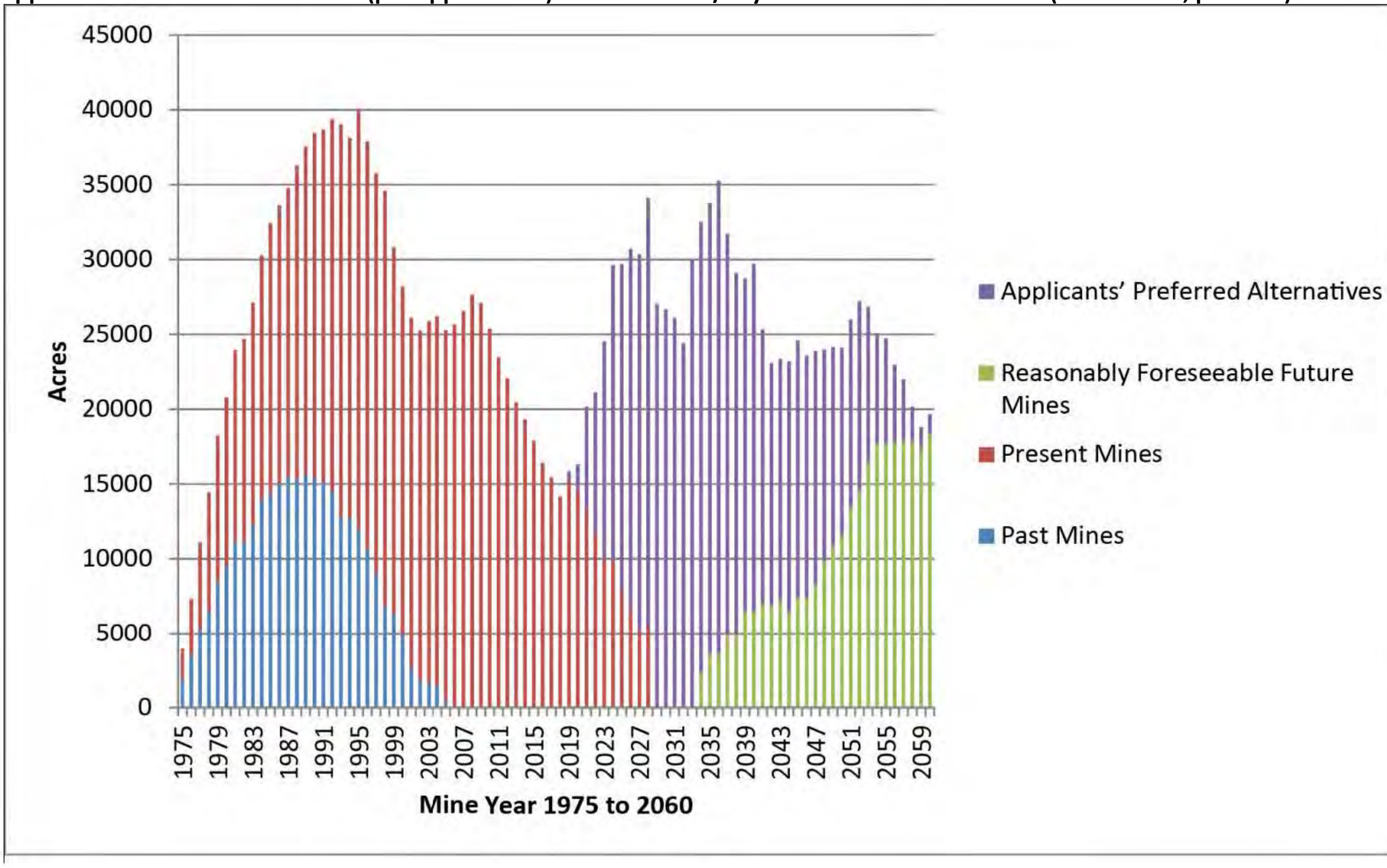
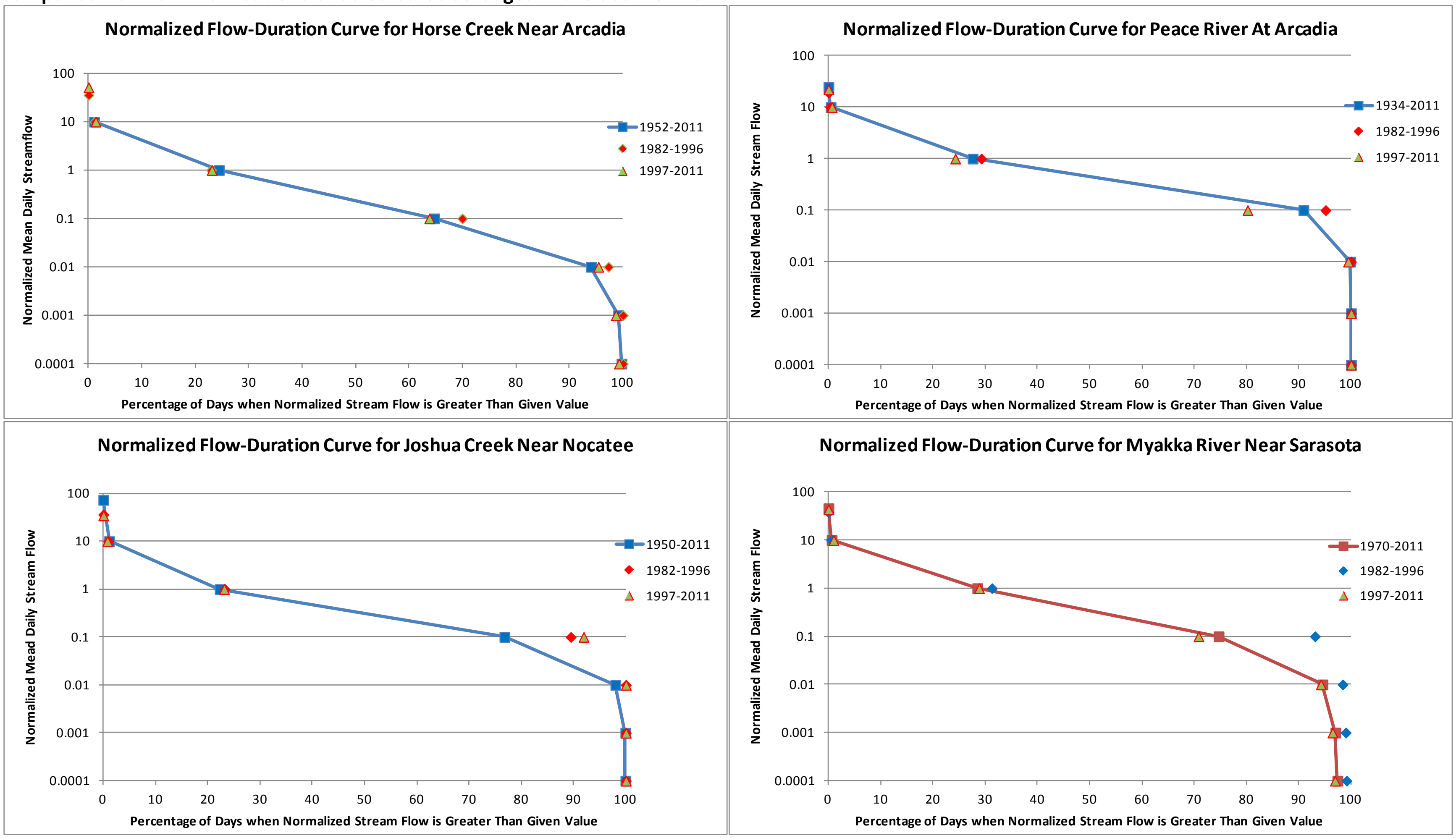


FIGURE 112

Comparison of Flow Distributions of Selected USGS Gages in the Southern CFPD



Note: Normalized by the Long-Term Average Daily Flow over the Referenced Time Frame

6.4 Potential Magnitude of Impacts from Mining

This section provides a bounding analysis of the maximum potential reduction in the low flow days at the PRMRWSA intake. As shown in Figure 107, the level of active phosphate mining has varied somewhat over the past 35 years, but is now at about 20,000 acres, down from a peak of nearly 40,000 acres. These acreages are an approximation of the amount of land that may capture and reuse stormwater. New mining from the Applicants' Preferred Alternatives would continue at a level of about 25,000 to 30,000 acres per year. Since rules pertaining to reclamation are stringent and require more stream restoration than prior to 2005, it also stands to reason that future reclamation would be at least as effective as reclamation in those areas recently mined and released. It likewise stands to reason that any effects from mining phosphate are already included in the flow record and that the utilities that rely on surface water supply already deal with the high variability in flow. Furthermore, as land use change to more urbanization or by converting pasture to row crops, more flow is expected to reach the lower Peace River both on an annual and seasonal basis (Section 5). In addition, as one moves into the southern portion of the CFPD, the relative surface water delivery increases (see Figure 106); therefore, reductions in contributing drainage area may have a somewhat higher effect downstream.

When scientists simulate the hydrologic response of future or alternative cases, the rainfall is typically held constant while land use and/or other parameters in the model are changed. A water balance simulation is typically based on a continuous time series of precipitation[9] record that ranges from 1 to 10 years depending on the complexity of the model and objectives. For example, the Peace River Cumulative Impact Study (PBS&J, 2007) simulated the hydrology over 3-year continuous rainfall periods selected from four periods in time to capture the results of differing rainfall amounts. To estimate into the future, the AEIS team would typically rely on historic rainfall data, although there are some stochastic rainfall prediction models available. Instead of trying to simulate rainfall/runoff for a hypothetical future condition, a simpler bounding method was applied to the USGS daily data in the Peace River for the PRMRWSA intake location. The same methodology cannot be applied to the North Port intake because of a lack of flow data[10].

The availability of surface water is most critical during times of drought, and the worst cases are during extended droughts. The utility can withdraw water during higher flow periods and store excess pumped water for times of drought. The PRMRWSA has both surface and underground reservoirs for storage. As discussed previously, the permit for surface water is related to a low flow threshold of 130 cfs, based on the sum of the three USGS gages at Horse Creek, Joshua Creek, and Peace River at Arcadia. This flow level is roughly near the lowest 10th percentile flow of these gages under recent conditions (not counting the most recent drought). Therefore, the change in the number of days with surface water available for withdrawal would occur near the period of low surface water delivery. It would be expected that the active mines would be retaining most of the surface water during these times (notwithstanding the percolation from the ditch and berm systems to hydrate adjacent wetlands). Consequently, the maximum effect that the active mines could have is to remove the expected contribution from the area being actively mined (i.e., the 100 percent capture case) and to assume no increase in flow resulting from land use change (i.e., use the historic recorded flow data). To develop a conservatively high estimate of flow reduction, the USGS daily flow at the intake (i.e., the sum of three gages) was reduced by the fraction of the maximum potential future mined area in the lower Peace River. Also, because of the variation in the flow record, several time periods were discussed.

The estimated area of land captured under the mine plans for the three Applicants' Preferred Alternatives (Desoto, Ona, and South Pasture Mine Extension) and foreseeable offsite alternatives (Pioneer and Pine Level/Keys) peaked at just under 30,000 acres (29,449 acres in year 2036), with 24,635 acres in Horse Creek and

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[9] While some studies use daily rainfall, short time interval data are required if peak runoff rates are of interest. The more complex infiltration subroutines also require short-duration rainfall for best results (e.g., 15-minute duration or shorter). A long-term record of short-duration rainfall data is normally less available than daily records.

[10] Because the USACE has not received a formal application for phosphate mining in the Big Slough Basin, there is not an immediate requirement to analyze the effect on North Port's water supply. However, the site of a foreseeable mine, Pine Level/Keys Tract, is primarily in the Big Slough Basin. An evaluation of effects on the City of North Port's water supply should be conducted at the time an application is submitted to USACE (or FDEP).

only 4,814 acres in the Peace River at Arcadia subwatershed. The maximum area actively captured in each of these tributaries at any given time is 25,172 and 7,848 acres in the Horse Creek and Peace River at Arcadia gages, respectively. While a maximum of about 30,000 acres (with maximum mine area in both tributaries' added in 2036) is only 2.1 percent of the Peace River watershed, these locations are south of Fort Meade. In times of drought, the flow in the upper Peace River may not contribute further south because of low groundwater and river flow conditions (Metz and Lewelling, 2009). If one subtracts all drainage area north of the Zolfo Springs gage on the Peace River, then the maximum area captured is about 3.1 percent of the lower Peace River subwatersheds. Furthermore, some tributaries are expected to have higher surface water delivery than others (see Figure 106 and Table 4). The long-term adjustment factor (j, Table 4) used in estimating annual runoff is a measure of the relative contribution of different subwatersheds. When the maximum potential active mine area is weighted by j, then the relative importance of these mined areas to the overall contributing area rises to an equivalent of 3.8 percent (3.8/3.1 = 1.22, or a 22 percent increase).

A summary the daily flow record reported on a monthly basis is presented in Table 97. The four time periods included in the table are:

- 1980 through 2011: The period of record after the ditch and berm systems started to be utilized for new mines
- 2009 through 2011: The latest 3-year period
- 1997 through 1999: A period looked at in the Cumulative Impact Study (PBS&J, 2007)
- 1998 through 2003: A period reviewed by the Peace River Integrated Model Study (the lowest rainfall in record occurred in 2000)

The average flow per month for these four periods is presented in Table 97. From these results, distinct dry and wet seasons are apparent, but the flow during March in the dry season is double the flow from the other dry months. In the recent dry period (2009 though 2011), the dry months' flows were especially low. The 1997 through 1999 period was relatively wet and the 6-year 1998 through 2003 period was not very low either, on average, except for the April and May months.

The tally of the number of days with flow below the MFL threshold of 130 cfs was divided into two parts: number of days with flow less than 130 cfs over the reported time period, and the number of days with flow less than 130 cfs decreased by 3.8 percent. Table 98 lists the number of days with reported flow less than 130 cfs. From this portion of the table (reported USGS flow data without reductions), three observations are of interest. First, the longer 32-year period has an average annual value of about 54 days per year with flows less than the threshold, and again there is high variability because the standard deviation in this statistic is 57.3, or a coefficient of variation of 105 percent (i.e., standard deviation divided by mean = 1.05). Second, the other three time periods evaluated vary above and below the average, so different periods of analysis will give a range of answers, as expected from the review of various literature sources. Finally, there were no days in September when the flow in the lower Peace River dropped below 130 cfs.

The number of low flow days changed when the recorded flow was reduced by 3.8 percent. The total number of days with flows under the threshold is listed in Table 99. The difference in the averages over the four periods is about 3.7 days, or rounded to 4 days per year, with a range of about 2 to 5 days per year. Again, by using the USGS flow data, some impact from past and existing mining is already included in the record and so this would be a conservative estimate of future conditions (not counting for the release of existing mine areas).

TABLE 97
Average Daily Flow per Month for the Peace River near the PRMRWSA

Peace River Average Flow (cfs)				
Month	**1980-2011**	**2009-2011**	**1997-1999**	**1998-2003**
January	731	349	1,764	1,492
February	780	381	2,407	1,396
March	1,013	591	2,797	1,605
April	625	605	734	493
May	275	288	296	181
June	1,215	497	571	1,621
July	1,680	1,470	1,287	2,191
August	2,147	1,658	1,356	2,167
September	2,794	2,169	1,629	3,653
October	1,392	1,037	1,995	1,596
November	677	297	1,998	644
December	661	397	1,914	941
Grand Annual Average	1,167	814	1,559	1,498
No. of Years in Column's Data	32	3	3	6

Note: Analysis is based on the sum of 3 USGS gages used by PRMRWSA

TABLE 98
Estimate of Number of Low Flow Days in the Peace River with the USGS Flow Record

Month	1980-2011	2009-2011	1997-1999	1998-2003
January	150	31	4	31
February	113	15	0	38
March	187	45	27	68
April	258	30	41	82
May	431	39	17	104
June	197	26	11	49
July	41	0	4	17
August	2	0	0	0
September	0	0	0	0
October	36	0	0	12
November	142	4	0	30
December	185	14	0	31
Grand Total	1,742	204	104	462
Days per year (Average)	54.4	68.0	34.7	77.0
Standard Deviation	57.3			

Analysis is based on the Sum of 3 USGS gages used by PRMRWSA

TABLE 99
Estimate of Number of Low Flow Days in the Peace River with the USGS Flow Record Reduced by 3.8 Percent

Month	1980-2011	2009-2011	1997-1999	1998-2003
January	162	31	7	31
February	124	17	3	39
March	201	48	32	70
April	271	30	41	86
May	447	42	18	106
June	202	26	13	52
July	47	0	4	18
August	2	0	0	0
September	0	0	0	0
October	44	0	0	12
November	161	6	0	30
December	199	14	0	31
Grand Total	1860	214	118	475
Days per year (Average)	58.1	71.3	39.3	79.2
Difference in Days per Year from Part A (i.e., more days)	3.7	3.3	4.7	2.2

Analysis is based on the Sum of 3 USGS gages used by PRMRWSA

Another limitation of this analysis is that it is not an operations study of the PRMRWSA storage and treatment systems. While water may be available in the river, the full capacity of the withdrawal pumping system may not be utilized if the storage is full later in the wet season. For example, if a reduction in flow prevents pumping that may have occurred in April and May by 4 days, the utility may be able to pump more water later in September or October to make up that volume in their reservoir. The PRMRWSA has a complex water supply system that involves multiple communities and is, or has plans to be, integrated with the City of North Port, Sarasota, and Punta Gorda systems (HDR Engineering, Inc. [HDR], 2008). A detailed operations study is beyond the scope of the AEIS. However, another analysis of the potential pumped volume was applied to the USGS flow data.

The PRMRWSA has withdrawal limits within its water use permit that allow withdrawals of varying amounts depending on the flow (as reported by the SWFWMD MFL study, 2010c). These limits were applied to the two data records (observed and observed less 3.8 percent) for the 1998 through 2003 time period (6 years). This time period was selected because it included a mixture of high and low flows. The pumping capacity of the Peace River intake was limited to 185.6 cfs (120 mgd), the current capacity of the structure. The reduction in volume available for withdrawal given the existing permit limits and a 3.8 percent flow reduction was 98.7 percent of the volume could be pumped with no reduction in flow (or, a 1.3 percent volume reduction; not a 1:1 reduction in volume pumped). Over this 6-year period, this reduction in volume averaged about 0.85 mgd if all of the available water allowed in the PRMRWSA permit was pumped during this time period assuming that there would be storage available when river water was available.

The assessment conducted for the AEIS can be used only to provide a relative estimate of the extent to which surface water flows might be reduced during low flow days at the PRMRWSA intake. This is a reasonable limitation considering the following factors:

- The high variability in flows and weather (Section 6.2)
- The fact that existing active mining area is not increasing (Figure 107)
- The uncertainty associated with projections of future land uses (Section 3)

Depending on the period of record used in the analysis of recorded data, the average number of days when water could not be withdrawn at the PRMRWSA intake ranged from 35 to 77 days per year. This analysis indicates that the increase in the number of days when water could not be withdrawn is about 2 to 5 additional days per year (again depending on the period of record used in the analysis, Table 99). This represents about a 1.3 percent reduction in the volume available to be withdrawn (according to the permit limits) when the USGS flow record is reduced by 3.8 percent.

By using observed data, though, no additional allowance is required for existing impacts of surface water capture at the current mine operations in the flow record. The surface water delivery from the southern tributaries is expected to be higher than in the more northern reaches of the Peace River watershed, about 22 percent higher than an unweighted area-based average. Therefore, while it is possible that a greater relative effect could occur as the area being mined moves further south in the lower Peace River, the portion of the reduction that could be attributed to location would be small (specifically, a 22 percent of 5 days per year effect is about a 1 day per year increase attributed to the southerly location). Indeed, impacts from existing mines are already reflected in the flow record and are considered minor (Figure 108); however, it is possible that reductions could be masked by other low flow influences like agricultural irrigation return flow (PBS&J, 2007).

Despite the difficulty in discerning changes to low flows in the record, given the variability of potential low flow days and ignoring the potential for increased surface water from land use changes, this bounding analysis indicates that the maximum effect would be small (2 to 5 days, or less, or about 0.85 mgd). Considering that the SWFWMD predicts in their water supply plan that there is an additional 80 mgd of surface water still available to users in the Peace River (SWFWMD, 2010a), the maximum potential impact is small. The expected effect of land use changes on surface water delivery is predicted to increase by the time of maximum disturbance (2030 to 2040) by 1 to 4 percent over the existing 2009 annual dry season flow (Table 85). The future flow analysis included the capture of surface water, so the change in land uses would likely offset measureable changes in the number of low flow days from the Applicants' Preferred Alternatives.

7.0 Summary and Conclusions

Phosphate mining disrupts large areas at a time. The land is stripped and excavated to access the matrix with the ore. Historically, poor management and reclamation practices have led to increasing regulation and improvements to the mining activities. Current practices require isolating the mining areas, reducing groundwater use by utilizing stormwater that falls on the active sites, protecting surrounding wetlands from excessive dewatering, regulating water and wetland impacts by a variety of permits, and adopting improved reclamation practices that are also enforced by permit. The four Applicants' Preferred mines would be primarily south of and some are adjacent to existing mines. Through the AEIS process, two additional alternatives were identified as lands that may be mined within the 50-year time frame of the AEIS (Pine Level/Keys and Pioneer Tracts Alternatives). These two offsite alternatives most likely would be developed as extensions of Applicants' Preferred Alternatives and would begin operation further out in the future. However, the impacts predicted here would be similar if these offsite alternatives were moved forward in time, when compared to the No Action Alternative results. Finally, two additional offsite alternatives, Sites A-2 and W-2, were evaluated qualitatively because of their tentative schedule and lack of available information about their mining potential.

The impacts of phosphate mining are regulated at a local level by individual permits. The AEIS examines both the individual mines and their cumulative effect, including their additive impact because they would be operating at the same time. This evaluation examined many types of hydrologic effects on the surface water resources. A review of the land characteristics (soils, subwatershed, and topography), the applications, and the literature available that has assessed recent mining practices, indicated that a major effect of interest is the delivery of surface water downstream from phosphate mining land. Literature studies have examined these data in the past for current and past conditions, but none had done an analysis sufficient to account for the applications included in the AEIS for future conditions. Consequently, an analysis of the potential effects of the Applicants' Preferred and Pine Level/Keys and Pioneer Tracts Alternatives was necessary to determine the relative magnitude of impact to downstream surface waters flow. The assumptions used were conservative and provided a range of potential effects that were considered very conservative, such that these computations were judged to provide a high bounding analysis of potential reductions to seasonal and annual flows in the two watersheds where the Applicants' Preferred and Pine Level/Keys and Pioneer Tracts Alternatives would be between now and 2060. Land use projections were not available from the local agencies far enough into the future, or with sufficient consistency, for use in this study. Therefore, land use predictions were developed for 2020, 2030, 2040, 2050, and 2060 based primarily on historical land use change data derived from the 1990, 1999, and 2009 GIS coverages obtained from SWFWMD. Trends in land use were extended into the future based on past land uses and, in general, include increases in urbanization and the conversion of pasture land into row crops. The area of wetlands and open water remained relatively unchanged. Existing mining land was converted into primarily agricultural and wetlands land uses, at a rate similar to the reclamation schedules of past mines on record with the FDEP.

The runoff coefficient approach was used to evaluate various phosphate mining scenarios associated with the alternatives. No other hydrologic prediction tools (models) were available that covered the entire area of interest. The land use projections were used in conjunction with annual average rainfall values and the land use-specific runoff coefficients obtained for this study area from Janicki (2010) to create No Action Alternative flow predictions with none of the Applicants' Preferred Alternatives in operation. The methodology was calibrated to measured gage flow for specific USGS gage locations relevant to the locations of the alternatives. Because the coefficients were calibrated to USGS data that included lands being mined, past and present impacts are implicitly included in the results. The runoff coefficient approach predicted annual surface water delivery reasonably well and included seasonal values (wet and dry season coefficients). Considering that the land use had to be predicted far into the future, this runoff coefficient approach was judged as a scientifically reasonable method to evaluate relative potential effects of mines under various stages of operation and reclamation.

Capture area schedules were developed from mine plan information extracted from the Clean Water Act Section 404 permit applications for the four mines (Mosaic, 2011a; Mosaic, 2011b; Mosaic, 2011c; CF Industries, 2010a) and from conceptual mine plans independently developed for the Pine Level/Keys and Pioneer Tracts. The capture area analyses quantified the active mine areas that would retain and manage stormwater runoff during the periods of mining. To be conservative during dry conditions, it was assumed that no unregulated offsite discharge would occur from within the capture area. For the 100 percent capture case, these capture areas were essentially deleted from the applicable subwatersheds during the applicable mine operation periods. However, mines do discharge stormwater through their NPDES-permitted outfalls (as well as in unmined portions of the land and through seepage from the ditch and berm systems). The Applicants' water use permit applications contain water balances that indicated about 35 percent of the runoff would be kept onsite for internal use during operations. Therefore, a second conservative estimate of 50 percent capture was made to predict how much rainfall may be discharged as stormwater under less conservative conditions (i.e., not drought). The two cases (100 and 50 percent capture) supported the subsequent calculation of the potential effects of these mining activities on reductions to downstream flows for those subwatersheds. Combined, these two cases are conservative because wet years are not estimated.

Individually, for most of the subwatersheds the estimated changes in flows from each mine are small, although some of the relative percentages were low to moderate even though the magnitude of differences was a 1 to 3 cfs. The effects are most prominent in the Horse Creek subwatershed when all actions' predicted impacts are summed. It is estimated that the maximum impact to Horse Creek would occur in 2035, when the greatest amount of capture area is projected to be under the influence of the various mining projects. The AEIS analyses predicted that a worst case scenario would involve decreases from 2009 flows at the Horse Creek gage station in 2035 of 17 percent for the annual average flow, 18 percent for the dry season flow, and 15 percent for the wet season flow, all during average rainfall conditions when assuming 100 percent capture of stormwater for all actions. Assuming a 50 percent capture of stormwater yields estimates of a 7 percent decrease in average annual flows, an 8 percent decrease in dry season flow, and a 6 percent decrease in wet season flow in 2035.

The Big Slough Basin may experience a reduction in flows of approximately 7 percent compared to 2009 flows resulting from the influence of the Pine Level/Keys Tract Alternative in this Myakka River subwatershed. Flow changes estimated with mining at the individual alternatives in all other subwatersheds evaluated and in the

Peace River and Myakka River watersheds are expected to be negligible. In fact, when compared to 2009 flows, because of the changes in projected land use in these watersheds, annual and seasonal average flows are expected to increase slightly from the increase in urbanization and crop lands. For all of the subwatersheds and watersheds that may be influenced by these four Applicants' Preferred mines, flows to the affected subwatersheds would return to nearly No Action Alternative conditions by 2060, assuming that the projected schedules for the mined lands to be reclaimed and released are finished in that time period.

Deliveries of water to the upper Charlotte Harbor Estuary from the Peace River and from the Myakka River were estimated for the same projection years. During the years of maximum capture area influence, the results of the analysis indicated that water deliveries to the upper Charlotte Harbor Estuary from these two rivers would be increased when compared to 2009 flows because of increased urbanization and other land use changes, even when including the summed impacts of the alternatives. When compared to the No Action Alternative results, projected flows would be slightly reduced, although estimated flows would still be above those predicted for 2009.

An additional bounding analysis of the number of low flow days and available water was conducted for the Peace River at PRMRWSA's intake location. Because the existing mines would be reclaimed and released, and the total area that would be mined under the applications would not substantially change the amount of area mined, effects of mining should already be reflected in the flow monitoring record. However, as the new mines move south, some of the potential stormwater in these areas could more effectively reach the Peace River outlet. It is conservatively estimated that the new mines could reduce the number of days that water could be withdrawn at the PRMRWSA intake by 2 to 5 per year. The reduction in volume of water withdrawn would also be small (maximum 1.3 percent). The actual reductions in any year vary significantly because of the wide range of flows and the utilities already have storage and interconnections in place to help deal with this variability. Flow is expected to increase at the intake location as a result of land use changes in the watershed by more than the mine capture area reductions would be in the future. The Pine Level/Keys Tract could not be assessed at the City of North Port's intake because of a lack of flow data for a period long enough for a reasonable analysis.

The potential effects of these mines were considered small to negligible depending on the subwatershed. The other two offsite alternatives, Sites A-2 and W-2, were evaluated qualitatively by comparing their size and location in relation to those alternatives with mine plans. Their impact is expected to be bounded by those quantified in the TM, and are thus also considered minor. Horse Creek would be the most affected by the new mines. However, given the wide range of flows recorded during and between years, it would be difficult to measure this effect (less than 10 percent change in annual values). The effect of the Applicants' Preferred Alternatives and offsite alternatives on the utilities withdrawing surface water from the downstream end of the two watersheds would also be difficult to discern because of the existing variable flow rates and range of low flow days without available water.

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Attachment A
SWFWMD Rainfall Data for Region

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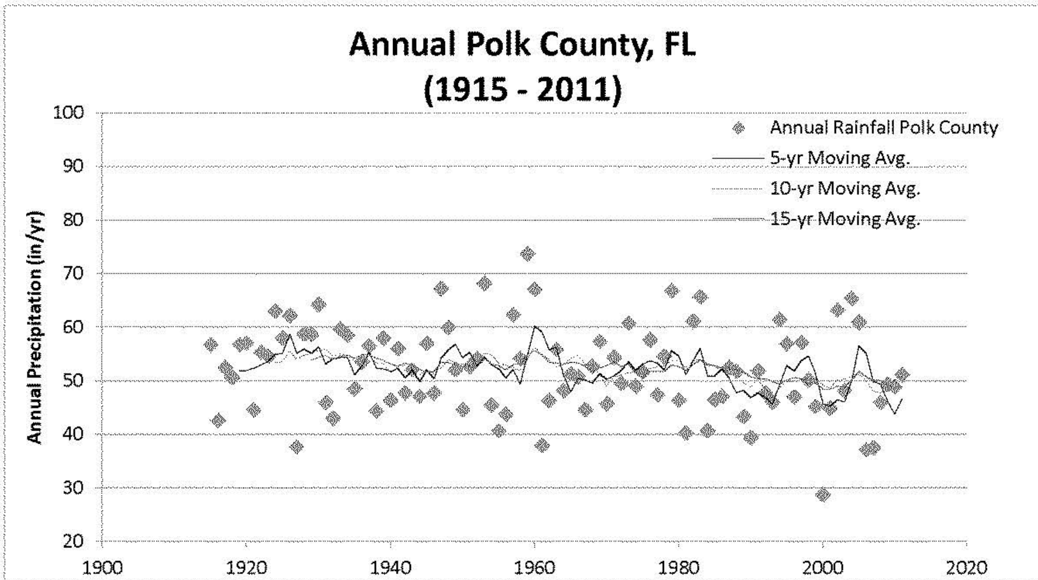

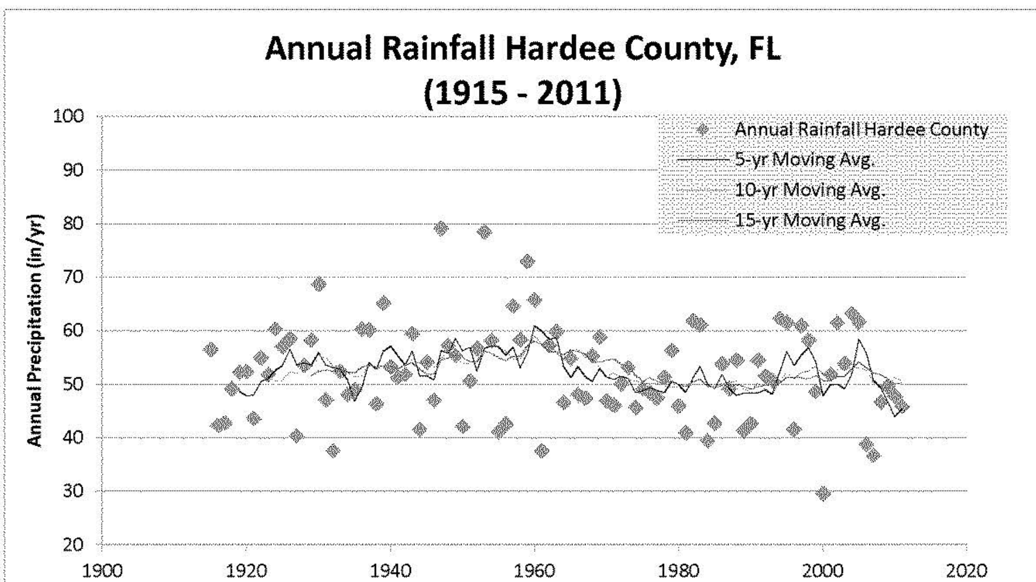

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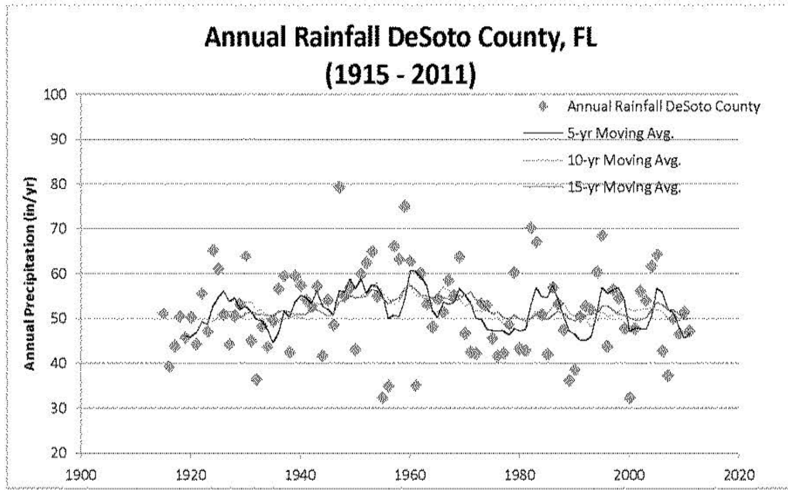

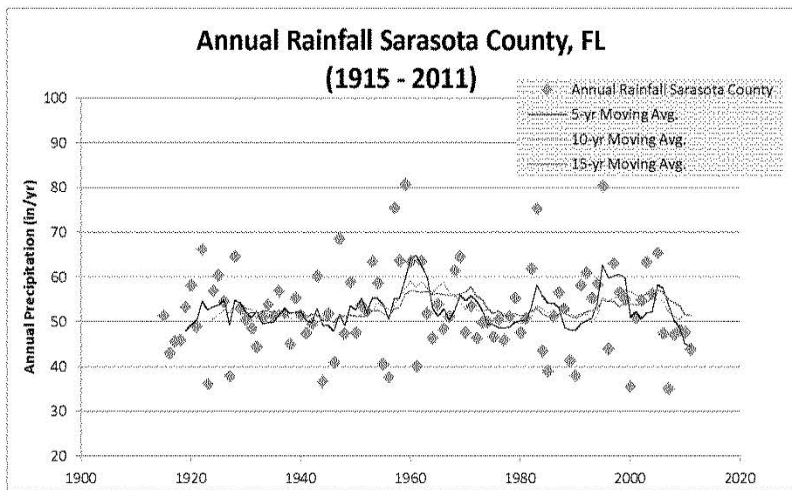

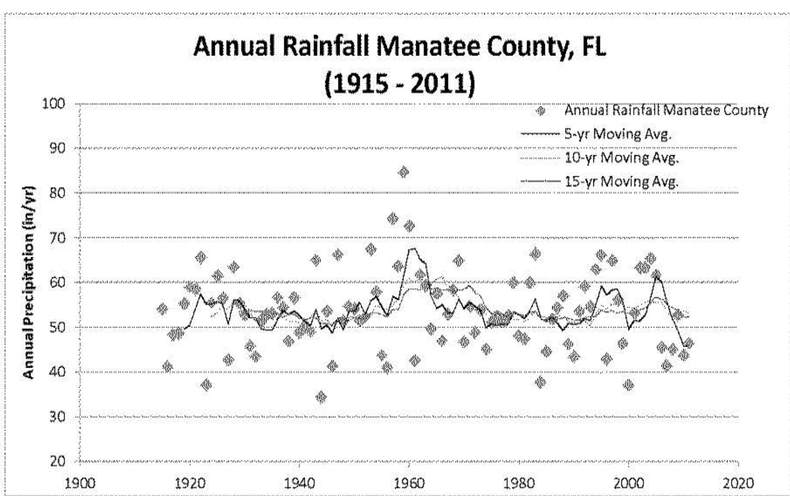

Source: http://www.swfwmd.state.fl.us/data/wmdbweb/rainfall_data_summaries.php

Summary Statistics of Rainfall Records in Selected Counties in Southwest Florida (1915 through 2011)

Polk County

Month	January	February	March	April	May	June	July	August	September	October	November	December	Annual
MIN	0.04	0.14	0.30	0.00	0.41	1.53	3.10	3.94	1.11	0.11	0.02	0.10	28.81
MEAN	2.37	2.70	3.37	2.63	4.15	7.85	7.96	7.51	6.69	2.93	1.77	2.11	52.03
MAX	7.04	8.93	10.40	8.33	14.26	15.84	14.59	14.46	15.97	8.48	7.11	12.02	73.76
P20	0.85	1.00	1.31	1.14	1.91	5.87	6.21	5.67	4.33	1.20	0.49	0.64	45.57

Hardee County

Month	January	February	March	April	May	June	July	August	September	October	November	December	Annual
MIN	0.05	0.03	0.23	0.05	0.30	2.41	3.42	3.29	1.32	0.14	0.03	0.09	29.63
MEAN	2.16	2.57	2.97	2.64	3.92	8.34	8.18	7.56	7.25	3.10	1.69	1.85	52.22
MAX	7.49	8.97	10.00	8.49	12.28	16.63	14.82	15.73	15.72	9.77	9.45	8.00	79.21
P20	0.68	1.03	0.95	1.07	1.84	5.63	6.16	5.53	4.69	1.41	0.44	0.66	45.77

DeSoto County

Month	January	February	March	April	May	June	July	August	September	October	November	December	Annual
MIN	0.00	0.01	0.09	0.03	0.12	2.72	2.10	2.87	1.92	0.02	0.01	0.06	32.32
MEAN	2.00	2.41	2.89	2.45	3.79	8.38	7.98	7.66	7.39	3.34	1.73	1.79	51.81
MAX	7.66	10.84	8.49	7.90	11.40	19.58	16.00	15.97	16.85	13.05	5.56	7.29	79.38
P20	0.50	0.85	0.92	0.90	1.85	5.35	5.56	5.51	4.99	1.27	0.49	0.60	43.44

Sarasota County

Month	January	February	March	April	May	June	July	August	September	October	November	December	Annual
MIN	0.00	0.01	0.13	0.00	0.20	2.22	2.45	2.37	3.28	0.00	0.00	0.00	35.11
MEAN	2.29	2.60	3.00	2.42	3.04	7.57	8.27	8.59	7.73	3.28	1.86	1.99	52.64
MAX	8.09	9.29	10.14	10.52	10.11	22.45	16.05	19.08	18.63	10.90	6.71	9.29	80.78
P20	0.68	0.92	0.81	0.65	1.23	4.20	6.15	5.96	5.19	1.28	0.49	0.70	46.00

Manatee County

Month	January	February	March	April	May	June	July	August	September	October	November	December	Annual
MIN	0.01	0.02	0.11	0.00	0.11	2.11	3.43	2.93	1.98	0.03	0.00	0.04	34.39
MEAN	2.42	2.77	3.11	2.43	3.15	7.62	8.63	8.86	7.52	3.11	1.86	2.06	53.55
MAX	7.71	9.17	10.36	9.05	10.19	19.96	17.65	18.31	16.38	11.33	7.70	10.35	84.75
P20	0.76	1.00	0.88	0.84	1.22	4.83	6.45	6.34	4.55	1.42	0.55	0.74	45.93

Source: http://www.swfwmd.state.fl.us/data/wmdbweb/rainfall_data_summaries.php

MIN, MEAN, and MAX are the minimum, mean, and maximum values per Month or Annual totals, respectively.

P20 is the lowest 20th Percentile Value per Month or Annual totals.

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Attachment B
Capture Area Analysis

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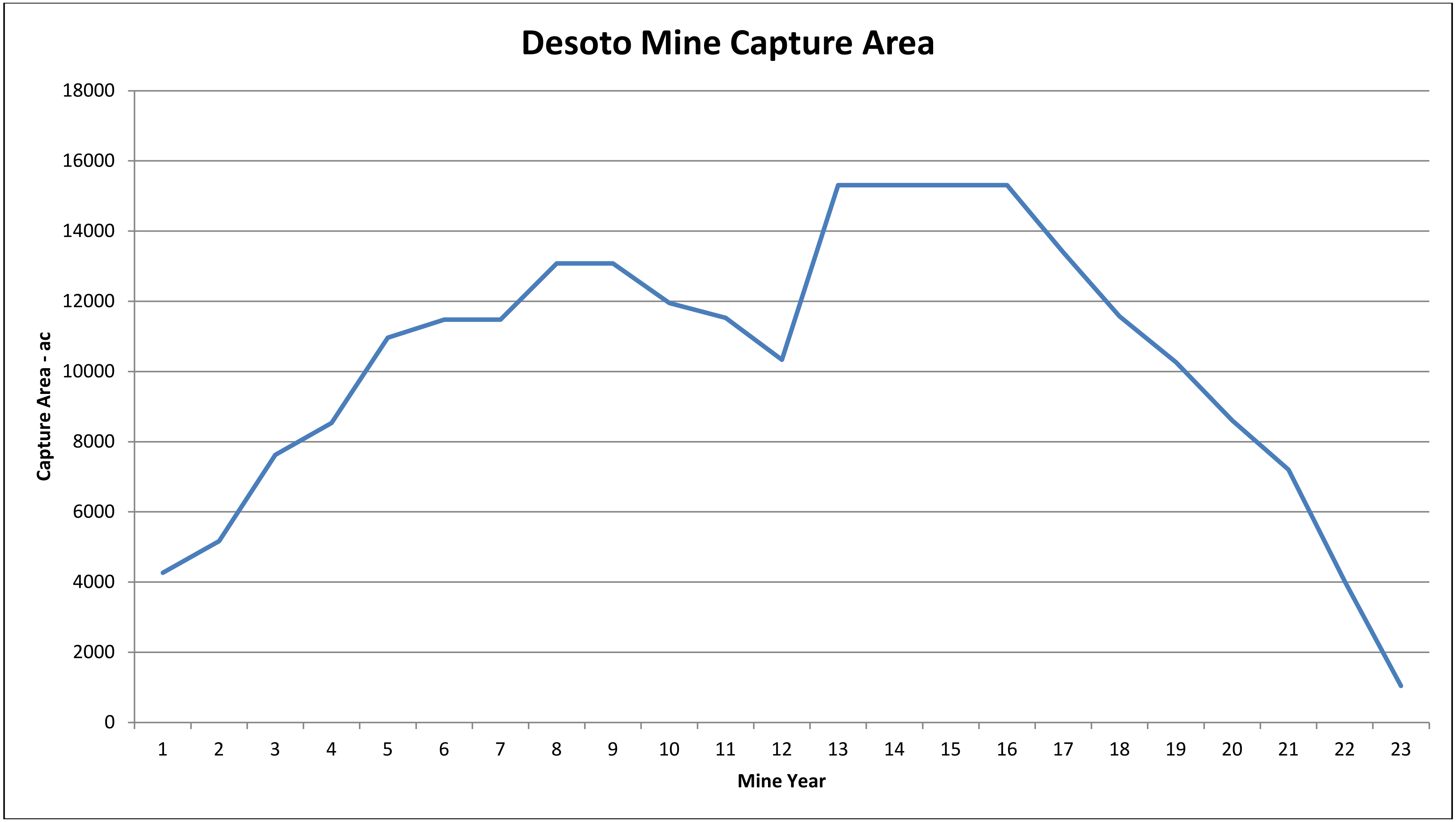
Desoto Mine Capture Area Analysis

Plant																		CSA					
CSA and others				D-1a & D-1b	D-2		Plant Site +			D-3a	D-3b	D-3c	D-4					4292					
Area	**ac**	900	1400	1307	966	550	640	800	400	482	511	505	521	1600	800	2000	420	220	400	1660	1920	280	**18,282**
Reclamation	**Area**	a	b	c	d	e	f	g	h	i	j	k	l	m	n	o	p	q	r	s	t	u	
Ditching	**Year**	13	13	1	1	1	1	1	13	2	4	5	6	8	3	13	2	10	4	3	5	13	
Release	**Year**	21	20	18	22	9	23	9	23	22	22	22	22	17	11	21	10	17	11	19	16	21	**Capture Area**
	Mine																						
	Year																						
2021	1			1307	966	550	640	800															4263
	2			1307	966	550	640	800		482							420						5165
	3			1307	966	550	640	800		482					800		420			1660			7625
	4			1307	966	550	640	800		482	511				800		420		400	1660			8536
2025	5			1307	966	550	640	800		482	511	505			800		420		400	1660	1920		10961
	6			1307	966	550	640	800		482	511	505	521		800		420		400	1660	1920		11482
	7			1307	966	550	640	800		482	511	505	521		800		420		400	1660	1920		11482
	8			1307	966	550	640	800		482	511	505	521	1600	800		420		400	1660	1920		13082
	9			1307	966	550	640	800		482	511	505	521	1600	800		420		400	1660	1920		13082
2030	10			1307	966		640			482	511	505	521	1600	800		420	220	400	1660	1920		11952
	11			1307	966		640			482	511	505	521	1600	800			220	400	1660	1920		11532
	12			1307	966		640			482	511	505	521	1600				220		1660	1920		10332
	13	900	1400	1307	966		640		400	482	511	505	521	1600		2000		220		1660	1920	280	15312
	14	900	1400	1307	966		640		400	482	511	505	521	1600		2000		220		1660	1920	280	15312
2035	15	900	1400	1307	966		640		400	482	511	505	521	1600		2000		220		1660	1920	280	15312
	16	900	1400	1307	966		640		400	482	511	505	521	1600		2000		220		1660	1920	280	15312
	17	900	1400	1307	966		640		400	482	511	505	521	1600		2000		220		1660		280	13392
	18	900	1400	1307	966		640		400	482	511	505	521			2000				1660		280	11572
	19	900	1400		966		640		400	482	511	505	521			2000				1660		280	10265
2040	20	900	1400		966		640		400	482	511	505	521			2000						280	8605
	21	900			966		640		400	482	511	505	521			2000						280	7205
	22				966		640		400	482	511	505	521										4025
	23						640		400														1040
	24																						
2045	25																						

Desoto Mine Capture Area Analysis

Plant																		CSA					
CSA and others				D-1a & D-1b	D-2		Plant Site +			D-3a	D-3b	D-3c	D-4					4292					
Area	**ac**	900	1400	1307	966	550	640	800	400	482	511	505	521	1600	800	2000	420	220	400	1660	1920	280	**18,282**
Reclamation	**Area**	a	b	c	d	e	f	g	h	i	j	k	l	m	n	o	p	q	r	s	t	u	
Ditching	**Year**	13	13	1	1	1	1	1	13	2	4	5	6	8	3	13	2	10	4	3	5	13	
Release	**Year**	21	20	18	22	9	23	9	23	22	22	22	22	17	11	21	10	17	11	19	16	21	**Capture Area**
	Mine																						
	Year																						
	26																						
	27																						
	28																						
	29																						
2050	30																						
	31																						
	32																						
	33																						
	34																						
2055	35																						
	36																						
	37																						
	38																						
	39																						
2060	40																						
	41																						
	42																						
	43																						
	44																						
2065	45																						

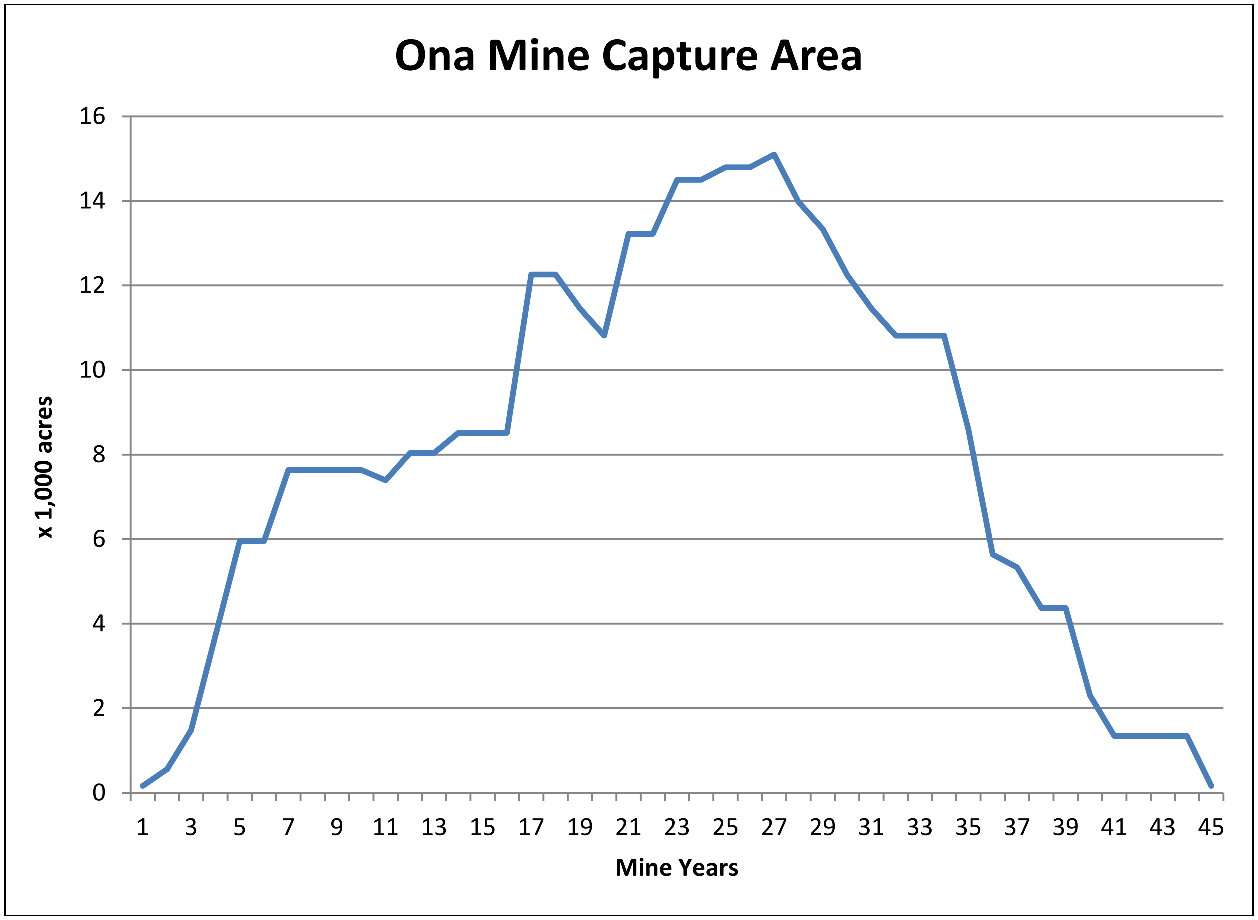

Desoto Mine Capture Area
Capture Area - ac
18000
16000
14000
12000
10000
8000
6000
4000
2000
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
Mine Year

Ona Mine Capture Area Analysis

CSA		O-1C					O-2		O-3A	O-3B						Plant	O-4A	O-4B	O-4C									CSA Area	6016	
Area (acres)		602	960	960	160	320	879	480	958	1185	960	640	800	240	300	160	160	2072	160	300	1280	1600	800	1920	640	640	19176			
Reclamation Area	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26				
Ditching Year		3	23	23	28	3	7	21	14	17	23	5	12	2	27	0	4	4	2	26	17	5	7	21	17	17				
Release Year		29	37	34	35	13	35	29	40	44	34	19	30	10	36	45	11	39	13	34	27	22	18	35	31	28	Cap-ture Area	Capture Area Myakka	Captu re Area Horse	Capture Area Arcadia
1																160											160	0	160	0
2														240		160			160								560	0	560	0
3		602				320								240		160			160								1482	0	1482	0
4		602				320								240		160	160	2072	160								3714	0	3714	0
5		602				320						640		240		160	160	2072	160			1600					5954	0	5954	0
6		602				320						640		240		160	160	2072	160			1600					5954	0	5954	0
7		602				320	879					640		240		160	160	2072	160			1600	800				7633	0	7633	0
8		602				320	879					640		240		160	160	2072	160			1600	800				7633	0	7633	0
9		602				320	879					640		240		160	160	2072	160			1600	800				7633	0	7633	0
10		602				320	879					640		240		160	160	2072	160			1600	800				7633	0	7633	0
11		602				320	879					640				160	160	2072	160			1600	800				7393	0	7393	0
12		602				320	879					640	800			160		2072	160			1600	800				8033	0	8033	0
13		602				320	879					640	800			160		2072	160			1600	800				8033	0	8033	0
14		602					879		958			640	800			160		2072				1600	800				8511	0	8511	0
15		602					879		958			640	800			160		2072				1600	800				8511	0	8511	0
16		602					879		958			640	800			160		2072				1600	800				8511	0	8511	0
17		602					879		958	1185		640	800			160		2072			1280	1600	800		640	640	12256	0	10976	1280
18		602					879		958	1185		640	800			160		2072			1280	1600	800		640	640	12256	0	10976	1280
19		602					879		958	1185		640	800			160		2072			1280	1600			640	640	11456	0	10176	1280
20		602					879		958	1185			800			160		2072			1280	1600			640	640	10816	0	9536	1280
21		602					879	480	958	1185			800			160		2072			1280	1600		1920	640	640	13216	0	11936	1280
22		602					879	480	958	1185			800			160		2072			1280	1600		1920	640	640	13216	0	11936	1280
23		602	960	960			879	480	958	1185	960		800			160		2072			1280			1920	640	640	14496	960	12256	1280
24		602	960	960			879	480	958	1185	960		800			160		2072			1280			1920	640	640	14496	960	12256	1280
25		602	960	960			879	480	958	1185	960		800			160		2072		300	1280			1920	640	640	14796	960	12556	1280
26		602	960	960			879	480	958	1185	960		800			160		2072		300	1280			1920	640	640	14796	960	12556	1280
27		602	960	960			879	480	958	1185	960		800		300	160		2072		300	1280			1920	640	640	15096	960	12856	1280
28		602	960	960	160		879	480	958	1185	960		800		300	160		2072		300				1920	640	640	13976	960	11736	1280
29		602	960	960	160		879	480	958	1185	960		800		300	160		2072		300				1920	640		13336	960	11736	640
30			960	960	160		879		958	1185	960		800		300	160		2072		300				1920	640		12254	960	10654	640

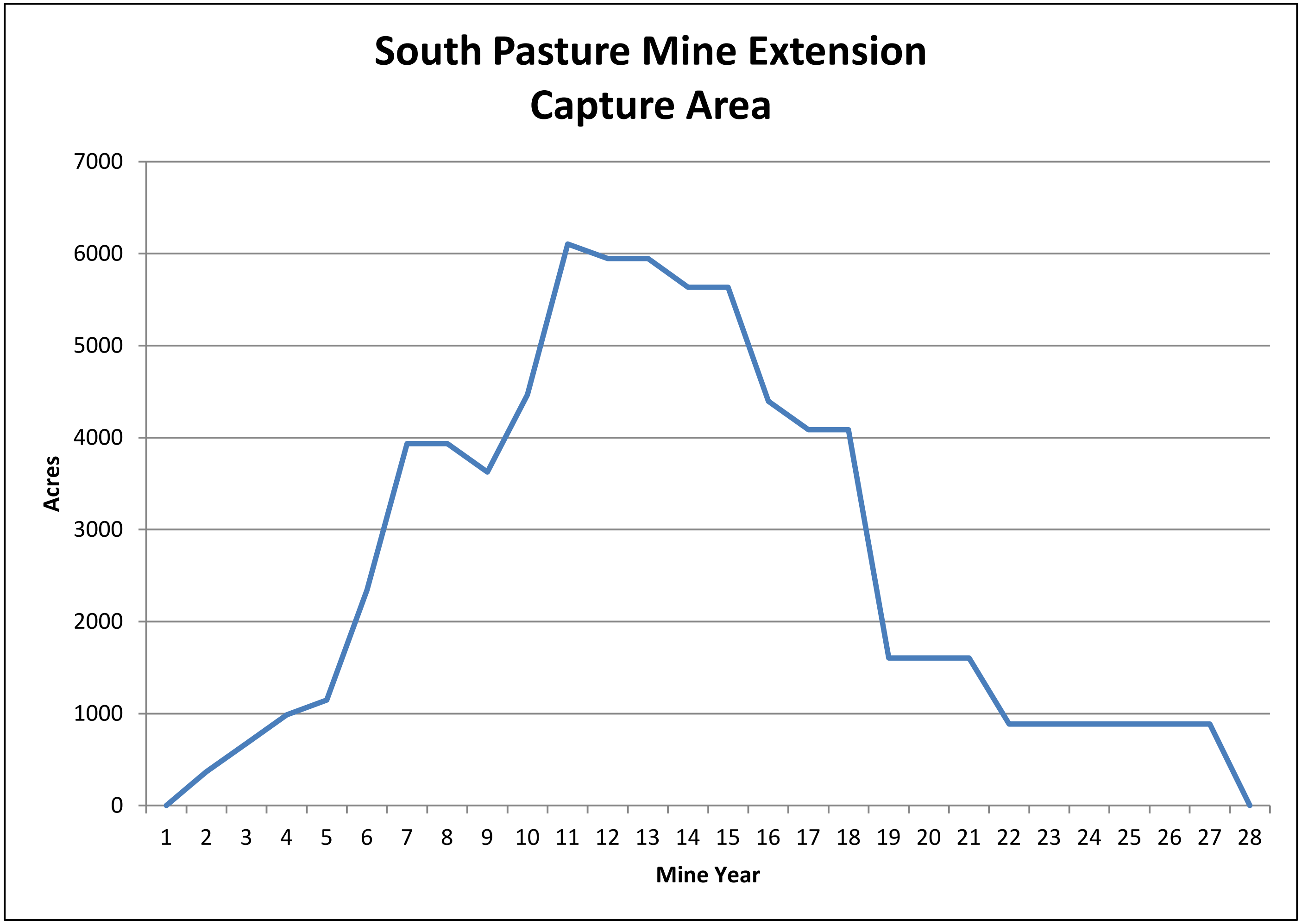
Ona Mine Capture Area Analysis

CSA		O-1C					O-2		O-3A	O-3B						Plant	O-4A	O-4B	O-4C									CSA Area	6016	
Area (acres)		602	960	960	160	320	879	480	958	1185	960	640	800	240	300	160	160	2072	160	300	1280	1600	800	1920	640	640	19176			
Reclamation Area	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26				
Ditching Year		3	23	23	28	3	7	21	14	17	23	5	12	2	27	0	4	4	2	26	17	5	7	21	17	17				
Release Year		29	37	34	35	13	35	29	40	44	34	19	30	10	36	45	11	39	13	34	27	22	18	35	31	28	Cap-ture Area	Capture Area Myakka	Capture Area Horse	Capture Area Arcadia
31			960	960	160		879		958	1185	960				300	160		2072		300				1920	640		11454	960	9854	640
32			960	960	160		879		958	1185	960				300	160		2072		300				1920			10814	960	9854	0
33			960	960	160		879		958	1185	960				300	160		2072		300				1920			10814	960	9854	0
34			960	960	160		879		958	1185	960				300	160		2072		300				1920			10814	960	9854	0
35			960		160		879		958	1185					300	160		2072						1920			8594	0	8594	0
36			960						958	1185					300	160		2072									5635	0	5635	0
37			960						958	1185						160		2072									5335	0	5335	0
38									958	1185						160		2072									4375	0	4375	0
39									958	1185						160		2072									4375	0	4375	0
40									958	1185						160											2303	0	2303	0
41										1185						160											1345	0	1345	0
42										1185						160											1345	0	1345	0
43										1185						160											1345	0	1345	0
44										1185						160											1345	0	1345	0
45																160											160	0	160	0


Ona Mine Capture Area
16
14
12
10
8
6
4
2
0
x 1,000 acres
1
3
5
7
9
11
13
15
17
19
21
23
25
27
29
31
33
35
37
39
41
43
45
Mine Years

South Pasture Mine Extension Capture Area Analysis

CSA		SPX 3				SPX 4				SPX 1 & 2		Capture Area
Block Area	ac	368	310	310	310	352	840	1640	1240	886	160	6416
Reclamation	Area	a	b	c	d	e	f	g	h	i	j	CSA Area
Ditching	Year	1	2	3	5	6	9	10	6	5	4	1606
Release	Year	20	12	7	15	20	17	17	14	26	10	
	Mining Years											
2018	0											0
2019	1	368										368
2020	2	368	310									678
2021	3	368	310	310								988
2022	4	368	310	310							160	1148
2023	5	368	310	310	310					886	160	2344
2024	6	368	310	310	310	352			1240	886	160	3936
2025	7	368	310	310	310	352			1240	886	160	3936
2026	8	368	310		310	352			1240	886	160	3626
2027	9	368	310		310	352	840		1240	886	160	4466
2028	10	368	310		310	352	840	1640	1240	886	160	6106
2029	11	368	310		310	352	840	1640	1240	886		5946
2030	12	368	310		310	352	840	1640	1240	886		5946
2031	13	368			310	352	840	1640	1240	886		5636
2032	14	368			310	352	840	1640	1240	886		5636
2033	15	368			310	352	840	1640		886		4396
2034	16	368				352	840	1640		886		4086
2035	17	368				352	840	1640		886		4086
2036	18	368				352				886		1606
2037	19	368				352				886		1606
2038	20	368				352				886		1606
2039	21									886		886
2040	22									886		886
2041	23									886		886
2042	24									886		886
2043	25									886		886
2044	26									886		886
2045	27											0


South Pasture Mine Extension
Capture Area
Acres
7000
6000
5000
4000
3000
2000
1000
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28
Mine Year

Wingate Mine East Capture Area Analysis

		WE-1	WE-2					Unmined				972									**Capture Area**
Area	**ac**	320	652	380	300	340	500	276	50	40	45	50	50	50	50	50	50	50	50	50	**3353**
Reclamation	**Area**	a-1	a-2	b	c	d	e	f	g-30	g-34	g-35	g-36	g-37	g-38	g-39	g-40	g-41	g-42	g-43	g-44	**CSA**
Ditching	**Year**	18	23	19	27	33	44		29	33	34	35	36	37	38	39	40	41	42	43	**972**
Release	**Year**	55	55	32	38	46	56	56	38	39	40	41	42	43	44	45	46	47	48	49	
	Mine Year																				
2019	18	320																			320
2020	19	320		400																	720
2021	20	320		400																	720
2022	21	320		400																	720
2023	22	320		400																	720
2024	23	320	652	400																	1372
2025	24	320	652	400																	1372
2026	25	320	652	400																	1372
2027	26	320	652	400				276													1648
2028	27	320	652	400	320			276													1968
2029	28	320	652	400	320			276													1968
2030	29	320	652	400	320			276	50												2018
2031	30	320	652	400	320			276	50												2018
2032	31	320	652	400	320			276	50												2018
2033	32	320	652	400	320	380		276	50												2398
2034	33	320	652		320	380		276	50	40											2038
2035	34	320	652		320	380		276	50	40	45										2083
2036	35	320	652		320	380		276	50	40	45	50	50								2183
2037	36	320	652		320	380		276	50	40	45	50	50								2183
2038	37	320	652		320	380		276	50	40	45	50	50	50							2233
2039	38	320	652		320	380		276	50	40	45	50	50	50	50						2283
2040	39	320	652			380		276		40	45	50	50	50	50	50					1963
2041	40	320	652			380		276			45	50	50	50	50	50	50				1973
2042	41	320	652			380		276				50	50	50	50	50	50	50			1978
2043	42	320	652			380		276					50	50	50	50	50	50	50	50	2028
2044	43	320	652			380		276						50	50	50	50	50	50	50	1978
2045	44	320	652			380	520	276							50	50	50	50	50	50	2448
2046	45	320	652			380	520	276								50	50	50	50	50	2398

Wingate Mine East Capture Area Analysis

		WE-1	WE-2					Unmined				972									Capture Area
Area	**ac**	320	652	380	300	340	500	276	50	40	45	50	50	50	50	50	50	50	50	50	**3353**
Reclamation	**Area**	a-1	a-2	b	c	d	e	f	g-30	g-34	g-35	g-36	g-37	g-38	g-39	g-40	g-41	g-42	g-43	g-44	**CSA**
Ditching	**Year**	18	23	19	27	33	44		29	33	34	35	36	37	38	39	40	41	42	43	**972**
Release	**Year**	55	55	32	38	46	56	56	38	39	40	41	42	43	44	45	46	47	48	49	
	Mine Year																				
2047	46	320	652			380	520	276									50	50	50	50	2348
2048	47	320	652				520	276										50	50	50	1918
2049	48	320	652				520	276											50	50	1868
2050	49	320	652				520	276												50	1818
2051	50	320	652				520	276													1768
2052	51	320	652				520	276													1768
2053	52	320	652				520	276													1768
2054	53	320	652				520	276													1768
2055	54	320	652				520	276													1768
2056	55	320	652				520	276													1768
2057	56						520														520


Wingate Mine East
Capture Area
Acres
3000
2500
2000
1500
1000
500
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41
Mine Year

Pine Level/Keys Capture Area Analysis (Reclamation Area A - XX)

Plant																												
CSA																												
Area (acres)			582	539	480	698	221	743	375	364	419	516	608	569	658	950	656	352	624	536	257	801	294	327	848	446	358	353
Reclamation Area			a	b	c	d	e	f	g	h	i	j	k	l	m	n	o	p	q	r	s	ss	t	u	v	w	x	xx
Ditching Year			1	1	1	2	4	6	9	10	8	11	7	14	11	12	17	15	17	16	14	19	21	21	19	23	19	19
Sand Tailings Year			6	8	6	8	11	12	12	12	13	16	13	19	17	18	23	19	21	21	22	23	25	25	25	28	27	23
Release Year			0	0	0	0	0	0	0	0	16	19	16	22	20	21	26	22	24	24	25	26	28	28	28	31	30	26
	Year as Extension	Mine Year*																										
	2034	1	582	539	480																							
		2	582	539	480	698																						
		3	582	539	480	698																						
		4	582	539	480	698	221																					
		5	582	539	480	698	221																					
		6	582	539	480	698	221	743																				
	2040	7	582	539	480	698	221	743					608															
		8	582	539	480	698	221	743			419		608															
		9	582	539	480	698	221	743	375		419		608															
		10		539		698	221	743	375	364	419		608															
		11		539		698	221	743	375	364	419	516	608			950												
	2045	12					221	743	375	364	419	516	608			950												
		13					221	743	375	364	419	516	608			950												
		14					221	743	375	364	419	516	608	569	658	950					257							
		15						743	375	364	419	516	608	569	658	950		352			257							
		16									419	516	608	569	658	950		352		536	257							
	2050	17										516		569	658	950	656	352	624	536	257							
		18										516		569	658	950	656	352	624	536	257							
		19										516		569	658	950	656	352	624	536	257	801			848		358	
		20												569	658	950	656	352	624	536	257	801			848		358	353
		21												569	658		656	352	624	536	257	801	294	327	848		358	353
	2055	22												569	658		656	352	624	536	257	801	294	327	848		358	353
		23													658		656		624	536	257	801	294	327	848	446	358	353
		24															656		624	536	257	801	294	327	848	446	358	353
		25															656				257	801	294	327	848	446	358	353
		26															656					801	294	327	848	446	358	353
	2060	27																					294	327	848	446	358	

Pine Level/Keys Capture Area Analysis (Reclamation Area A - XX)

Plant																												
CSA																												
Area (acres)			582	539	480	698	221	743	375	364	419	516	608	569	658	950	656	352	624	536	257	801	294	327	848	446	358	353
Reclamation Area			a	b	c	d	e	f	g	h	i	j	k	l	m	n	o	p	q	r	s	ss	t	u	v	w	x	xx
Ditching Year			1	1	1	2	4	6	9	10	8	11	7	14	11	12	17	15	17	16	14	19	21	21	19	23	19	19
Sand Tailings Year			6	8	6	8	11	12	12	12	13	16	13	19	17	18	23	19	21	21	22	23	25	25	25	28	27	23
Release Year			0	0	0	0	0	0	0	0	16	19	16	22	20	21	26	22	24	24	25	26	28	28	28	31	30	26
	Year as Extension	Mine Year*																										
		28																					294	327	848	446	358	
		29																								446	358	
		30																								446	358	
		31																								446		
	2065	32																										
		33																										
		34																										
		35																										
		36																										
	2070	37																										
		38																										
		39																										
		40																										
		41																										
	2075	42																										
		43																										
		44																										
	2078	45																										

* Mining stops in mine year 32.

Pine Level/Keys Capture Area Analysis (Reclamation Area Y - DD)

Plant								Recla-mation	CSA				Recla-mation Parcels	CSA	Total Recla-mation	Preser-vation	Total Mine Acres
CSA								17,491	2817								
Area (acres)			657	762	212	927	706	653	687	694	607	829	17,490	2,817	20,308	3,797	24,105
Reclamation Area			y	z	aa	bb	cc	dd	SE	SW	NE	NW	73%	12%	84%	16%	
Ditching Year			21	22	25	26	26	24	1	4	2	6					
Sand Tailings Year			26	28	28	32	32	30	31	31	36	37					
Release Year			29	31	31	35	35	33	33	33	39	40					
	Year as Extension	Mine Year*															
	2034	1							687						2288		
		2							687		607				3592		
		3							687		607				3592		
		4							687	694	607				4508		
		5							687	694	607				4508		
		6							687	694	607	829			6081		
	2040	7							687	694	607	829			6689		
		8							687	694	607	829			7108		
		9							687	694	607	829			7483		
		10							687	694	607	829			6785		
		11							687	694	607	829			8251		
	2045	12							687	694	607	829			7014		
		13							687	694	607	829			7014		
		14							687	694	607	829			8497		
		15							687	694	607	829			8628		
		16							687	694	607	829			7681		
	2050	17							687	694	607	829			7933		
		18							687	694	607	829			7933		
		19							687	694	607	829			9940		
		20							687	694	607	829			9777		
		21	657						687	694	607	829			10106		
	2055	22	657	762					687	694	607	829			10867		
		23	657	762					687	694	607	829			10392		
		24	657	762				653	687	694	607	829			10388		
		25	657	762	212			653	687	694	607	829			9441		
		26	657	762	212	927	706	653	687	694	607	829			10816		
	2060	27	657	762	212	927	706	653	687	694	607	829			9007		

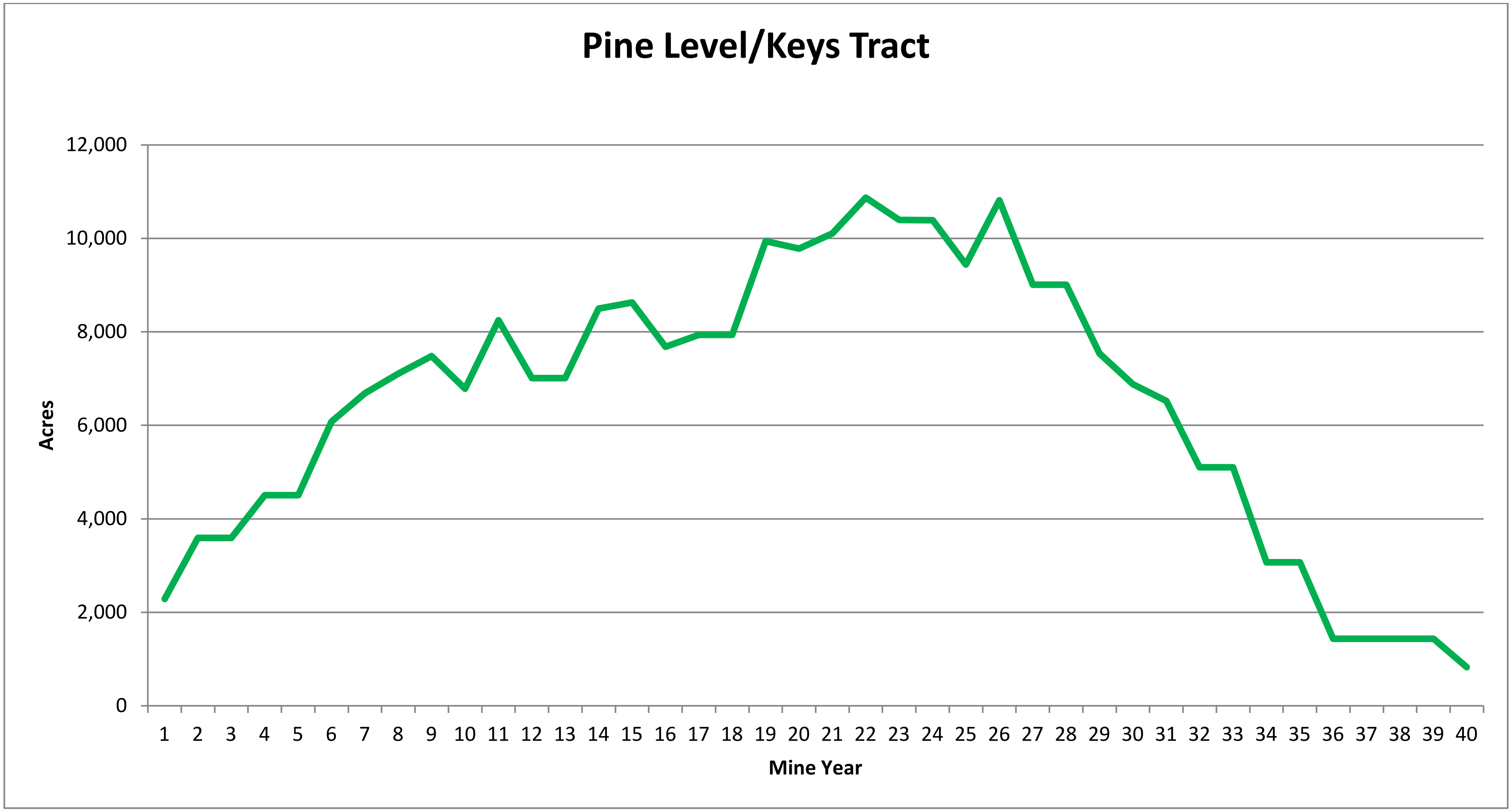
Pine Level/Keys Capture Area Analysis (Reclamation Area Y - DD)

Plant								Recla- mation	CSA				Recla- mation Parcels	CSA	Total Recla- mation	Preser- vation	Total Mine Acres
CSA								17,491	2817								
Area (acres)			657	762	212	927	706	653	687	694	607	829	17,490	2,817	20,308	3,797	24,105
Reclamation Area			y	z	aa	bb	cc	dd	SE	SW	NE	NW	73%	12%	84%	16%	
Ditching Year			21	22	25	26	26	24	1	4	2	6					
Sand Tailings Year			26	28	28	32	32	30	31	31	36	37					
Release Year			29	31	31	35	35	33	33	33	39	40					
	Year as Extension	Mine Year*															
		28	657	762	212	927	706	653	687	694	607	829			9007		
		29	657	762	212	927	706	653	687	694	607	829			7538		
		30		762	212	927	706	653	687	694	607	829			6881		
		31		762	212	927	706	653	687	694	607	829			6523		
	2065	32				927	706	653	687	694	607	829			5103		
		33				927	706	653	687	694	607	829			5103		
		34				927	706				607	829			3069		
		35				927	706				607	829			3069		
		36									607	829			1436		
	2070	37									607	829			1436		
		38									607	829			1436		
		39									607	829			1436		
		40										829			829		
		41															
	2075	42															
		43															
		44															
	2078	45															

* Mining stops in mine year 32.

Assumptions:	
1	Sand tailings completed 2 years after last year of mining in reclamation parcel
2	Land is cleared 1 year prior to mining
3	Reclamation is complete 3 years after sand tailings are complete
4	CSA 5 years after last filling reclamation starts

	Total Mine Acres	Years	Mine ac/yr
Draglines			
Green -1	5,493	28	196
Orange - 2	4,303	26	166
Red - 3	5,172	31	167
Yellow - 4	5,339	32	167
Average		29	174
Total Acres	20,308		


Pine Level/Keys Tract
Acres
12,000
10,000
8,000
6,000
4,000
2,000
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40
Mine Year

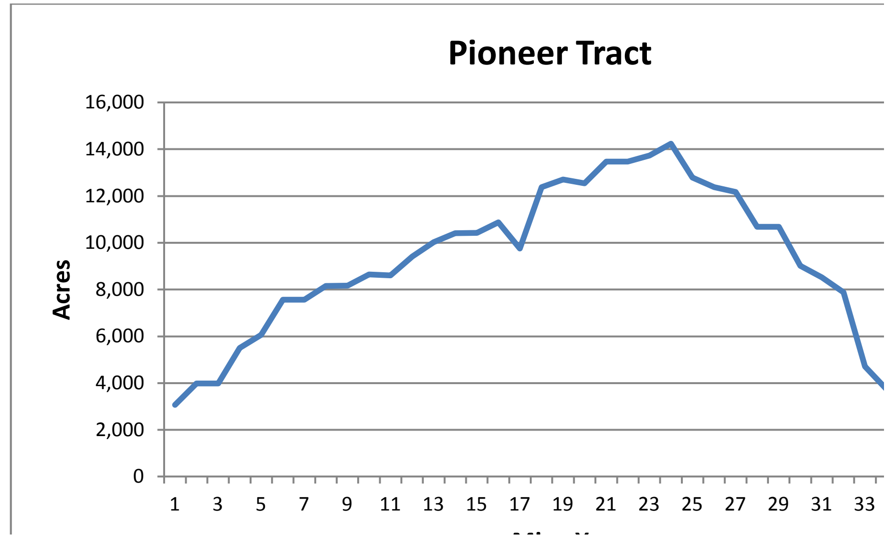
Pioneer Tract Capture Area Analysis (Sites 1-6 and A-U)

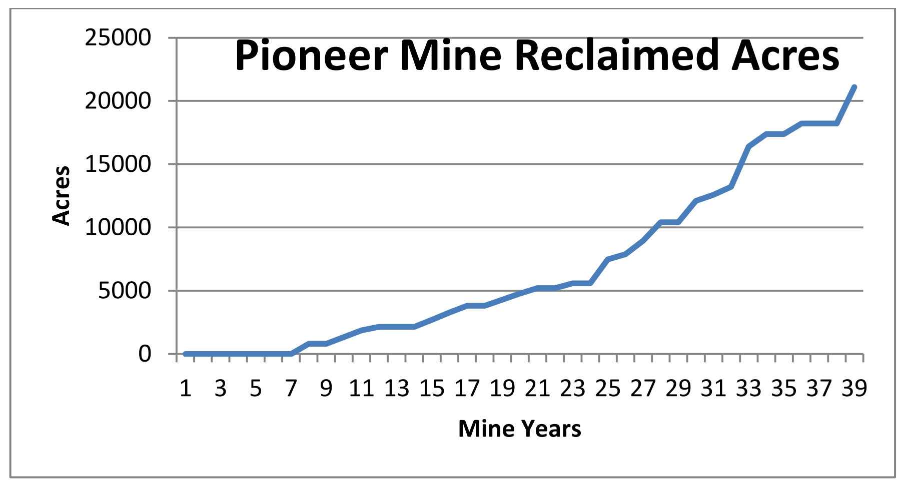
	Site ID	1	2	3	4	5	6	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U
	Acres	1,161	1,255	825	952	977	915	478	338	528	379	268	531	562	477	429	587	478	878	574	455	309	379	575	1,046	597	484	358
		R	R	R	Y	Y	Y	P	O	P	O	O	O	P	O	O	P	P	P	R	O	R	O	Y	R	P	Y	R
	D&B Year	1	4	9	1	6	12	1	1	2	2	4	6	5	10	12	8	11	13	15	16	20	14	18	18	18	21	21
Mine Year	Start	1	5	10	1	7	13	1	1	3	3	5	7	6	11	13	9	12	14	16	17	21	15	19	19	19	22	22
	End	30	24	30	24	24	30	2	2	5	4	6	10	8	12	14	10	13	18	18	18	21	16	21	20	21	24	23
start + 3 years Sand Tailings		35	29	35	29	29	35	5	5	8	7	9	13	11	15	17	13	16	21	21	21	24	19	24	23	24	27	26
3 yrs end Reclamation		38	32	38	32	32	38	8	8	11	10	12	16	14	18	20	16	19	24	24	24	27	22	27	26	27	30	29
As																												
Extension	Mine																											
	Year																											
2048	1	1161			952			478	338																			
	2	1161			952			478	338	528	379																	
2050	3	1161			952			478	338	528	379																	
	4	1161	1255		952			478	338	528	379	268																
	5	1161	1255		952			478	338	528	379	268		562														
	6	1161	1255		952	977		478	338	528	379	268	531	562														
	7	1161	1255		952	977		478	338	528	379	268	531	562														
	8	1161	1255		952	977		478	338	528	379	268	531	562			587											
	9	1161	1255	825	952	977				528	379	268	531	562			587											
	10	1161	1255	825	952	977				528	379	268	531	562	477		587											
	11	1161	1255	825	952	977				528		268	531	562	477		587	478										
	12	1161	1255	825	952	977	915					268	531	562	477	429	587	478										
2060	13	1161	1255	825	952	977	915						531	562	477	429	587	478	878									
	14	1161	1255	825	952	977	915						531	562	477	429	587	478	878				379					
	15	1161	1255	825	952	977	915						531		477	429	587	478	878	574			379					
	16	1161	1255	825	952	977	915						531		477	429	587	478	878	574	455		379					
	17	1161	1255	825	952	977	915								477	429		478	878	574	455		379					
	18	1161	1255	825	952	977	915								477	429		478	878	574	455		379	575	1046	597		
	19	1161	1255	825	952	977	915									429		478	878	574	455		379	575	1046	597		
	20	1161	1255	825	952	977	915									429			878	574	455	309	379	575	1046	597		
	21	1161	1255	825	952	977	915												878	574	455	309	379	575	1046	597	484	358
	22	1161	1255	825	952	977	915												878	574	455	309	379	575	1046	597	484	358
2070	23	1161	1255	825	952	977	915												878	574	455	309		575	1046	597	484	358
	24	1161	1255	825	952	977	915												878	574	455	309		575	1046	597	484	358
	25	1161	1255	825	952	977	915															309		575	1046	597	484	358
	26	1161	1255	825	952	977	915															309		575	1046	597	484	358
	27	1161	1255	825	952	977	915															309		575		597	484	358
	28	1161	1255	825	952	977	915																				484	358
	29	1161	1255	825	952	977	915																				484	358
	30	1161	1255	825	952	977	915																				484	
	31	1161	1255	825	952	977	915																					
	32	1161	1255	825	952	977	915																					
2080	33	1161		825			915																					
	34	1161		825			915																					
	35	1161		825			915																					
	36	1161		825			915																					
	37	1161		825			915																					
2085	38	1161		825			915																					

Pioneer Tract Capture Area Analysis (Sites V-DD and Totals)

	Site ID	V	W	X	Y	Z	AA	BB	CC	DD	Total	CSA	
	Acres	408	804	584	518	510	456	252	639	142	21,109	6,085	15,024
		O	O	R	P	Y	R	Y	R	R		29%	
	D&B Year	18	19	27	21	24	25	27	23	1	30 reclamation parcels average		
Mine Year	Start	19	20	28	22	25	26	28	24	1		24,834	
	End	19	23	29	23	27	27	29	25	4		Total	
start + 3 years Sand Tailings		22	26	32	26	30	30	32	28	7		Mine	501
3 yrs end Reclamation		25	29	35	29	33	33	35	31	10		Acres	ac per parcel

As Extension	Mine Year												
2048	1									142		3071	
	2									142		3979	
2050	3									142		3979	
	4									142		5502	
	5									142		6064	
	6									142		7573	
	7									142		7573	
	8									142		8159	
	9									142		8167	
	10									142		8644	
	11											8602	
	12											9417	
2060	13											10027	
	14											10406	
	15											10418	
	16											10873	
	17											9755	
	18	408										12382	
	19	408	804									12709	
	20	408	804									12539	
	21	408	804		518							13470	
	22	408	804		518							13470	
2070	23	408	804		518				639			13729	
	24	408	804		518	510			639			14239	
	25	408	804		518	510	456		639			12788	
	26		804		518	510	456		639			12380	
	27		804	584	518	510	456	252	639			12170	
	28		804	584	518	510	456	252	639			10689	
	29		804	584	518	510	456	252	639			10689	
	30			584		510	456	252	639			9009	
	31			584		510	456	252	639			8525	
	32			584		510	456	252				7887	
2080	33			584		510	456	252				4702	
	34			584				252				3736	
	35			584				252				3736	
	36											2900	
	37											2900	
2085	38											2900	





Dragline	Acres Mined	Years Mining	Average (ac/yr)
Red	7,348	29	253
Orange	4,468	23	194
Yellow	4,665	29	161
Purple	4,628	23	201
TOTAL	21,109		